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BY

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Associate Entomologist, Division of Cereal and Forage Insects
Bureau of Entomology

UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON, D.C.

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INTRODUCTION

The European corn borer (*Pyrausta nubilalis* Hübner), although in this country primarily a pest of corn, is generally acknowledged to have been carried to the United States in broomcorn (*6*, *8*, *4*), was first discovered here in dahlias (*7*, *4*), and has been found in the largest numbers on several occasions in cocklebur.[2]

[1] The writer wishes to thank all his coworkers from whose notes he has drawn information which aided in this work, and also those who have assisted in collecting data. Particular mention should be made of the early work on host plants by the late S. C. Vinal (*7*, *p. 15*); (Italic numbers in parentheses refer to "Literature cited," p. 63); of the work of D. J. Caffrey and G. W. Barber, whose observations and notes on the host plants have been extensive; of F. W. Grigg, who was associated with the author in the study of the host plants during the years 1919 to 1922, and whose botanical knowledge was an invaluable aid in this work; of W. O. Ellis, who determined many of the insect specimens in the new host plants; of H. J. Cronin, who conducted the surveys of market-garden crops and flowers in 1926 and 1927; and of G. W. Still, who assisted in preparing the figures and tables. Others who have assisted are Roland E. Garmon, Gilbert J. Haeussler, Charles W. Preston, Linton B. Sanderson, Milton J. Sawyer, Robert F. Sazama, and F. S. Vidler.

[2] On May 6, 1922, G. W. Barber found a cocklebur plant containing 167 larvae and 33 pupae, a total of 200, and on June 2 of the same year he found another plant containing 187 individuals, mostly pupae and pupal exuviae. On November 4, 1921, the author dissected five cocklebur plants which contained 312 larvae, with a maximum of 168 in one plant. In the latter case there was no indication that these borers were migrants; the plants were 3 feet or more high, well branched and wide spreading, offering an immense storehouse of food as well as ample protection for many larvae. The greatest number of larvae found in corn was 311, in a hill of sweet corn, and the maximum for one plant was 117, recorded by D. J. Caffrey at Medford, Mass., in 1918 (*7*, *p. 18*).

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In the initial study of the corn borer in New England it was found on more than 30 different kinds of plants, embracing vegetables, flowers, and weeds. Because of the range of plants involved, this phase of the investigational work has been given special attention. Many details have been considered because of their scientific interest and in order to make the work more complete. Some time has been given to searching out all the host plants and to a study of their relative infestation. Most effort has been applied to ascertaining the extent and nature of infestation and injury in the more important host plants. All the work, whether on preferred or on rare host plants, or on plants suspected of being hosts, has been done chiefly with a view to (1) learning the possibilities and importance of the insect as a pest, (2) serving as a basis for the establishment of adequate yet reasonable quarantine regulations, and (3) making possible the intelligent use of other measures for reducing or restricting the borer population and thus securing practical control.

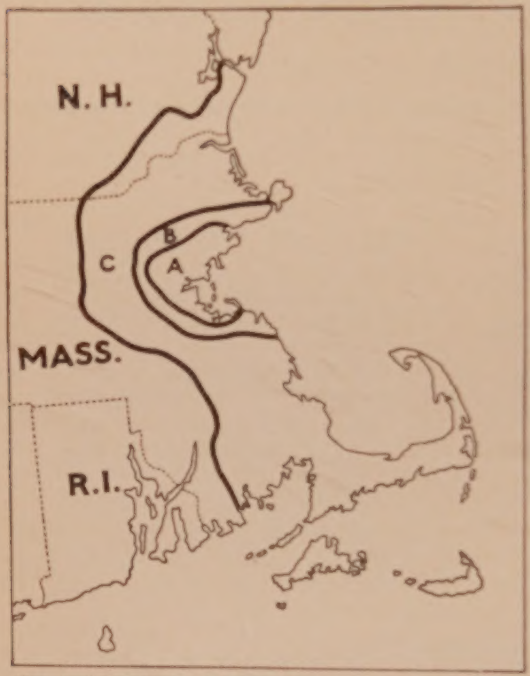

FIG. 1.—Intensity of European corn-borer infestation in New England in 1920. A, area in which corn was usually severely infested and other favorite host plants were frequently, sometimes severely, infested; approximate area, 200 square miles; B, area in which corn was usually found infested, but seldom severely, and other host plants were occasionally infested; approximate area, 225 square miles; C, area in which corn was either occasionally or lightly infested, and other favorite host plants were rarely infested. This area also includes all towns ever scouted and found infested. Approximate area, 1,985 square miles. The total area of infested territory was approximately 2,410 square miles

Although research on the host plants of the corn borer has been carried on from the beginning of the investigations in 1917, and over the entire infested area, most of the work reported herein, with the exception of that on corn and a few other favored host plants, was done during the period from 1919 to 1922, inclusive, and within the area where corn is commonly infested. The greatest variety of host plants has been found in locations of severe infestation, whereas in the lightly infested areas only the more favored hosts are attacked.

The year 1920 was typical of the period when the greatest number of new host plants were being found and the greatest number of notes made on the known hosts. (Fig. 1.)

The total area of infestation in New England has more than doubled since 1920. The area of more or less frequent infestation has increased regularly every year, and the areas of severe infestation have fluctuated from year to year, in some years being smaller and in other years larger and more scattered than in 1920.

GENERAL CONSIDERATION OF THE HOST PLANTS

The host plants represent 131 genera of 40 plant families, ranging from Equisetaceae to Asteraceae. (Table 8.) The family Poaceae, to which corn belongs, is the one best represented, excepting that large and rather inclusive group, Asteraceae. Other families well represented are Polygonaceae, Chenopodiaceae, Amaranthaceae, Brassicaceae, Rosaceae, Fabaceae, Malvaceae, Menthaceae, and Solanaceae. The genera best represented by number of species and varieties are Holcus, Chaetochloa, Rumex, Polygonum, Chenopodium, Beta, Amaranthus, Brassica, Rubus, Phaseolus, Solanum, Solidago, Aster, Xanthium, Bidens, Chrysanthemum, Artemisia, and Centaurea. That the members of these families and genera (especially the latter) constitute the more important hosts does not necessarily follow. A number of important host plants are not included in the foregoing list of genera, and many of the plants included, sometimes even whole genera, are not important as hosts. The latter is true of Brassica, Rubus, Solidago, Aster (this does not refer to China aster, *Callistemma chinense*), and Centaurea. On the other hand, certain genera, especially Holcus, Polygonum, Beta, Xanthium, Bidens, and Artemisia, contain very important hosts.

The number of species, botanical varieties, and more important horticultural varieties upon which, or in which, one or more stages (egg, larva, pupa, or imago [3]) have been found is well over 200. The exact number varies according to how many horticultural varieties are recognized.[4] In addition to the plants officially recorded there are doubtless a number of others, as only the infested plants have been included for which authentic determinations of both the plant and the insect have been obtained. The probable hosts not included in this list fall into the following groups: (1) Plants infested infrequently, specimens of which, unfortunately, have not been found; (2) plants found infested at a time of year when the plant specimens could not be definitely identified; and (3) plants upon which the insect was not authentically determined, including some of those reported by florists and gardeners. Among the latter are *Pelargonium domesticum*, *Hibiscus syriacus*, peach (windfall fruit and young shoots), maple (sprout from an old stump near corn), and Chinese cabbage. Eggs which were probably those of the corn borer have been found on dandelion, oxalis, plantain, rye, and lettuce.

On the other hand, unofficial reports concerning several plants as hosts are to be doubted. Carnations have been reported by several growers as host plants of the borer. The only case investigated, however, proved to be an infestation by *Phlyctaenia terrealis* Tr., the work of which resembles that of the corn borer (*5, p. 786*). Iris has been reported as a host plant, but in no examination of this plant have corn borers been found. The iris borer, *Macronoctua onusta* Grote, frequently was found, and this might easily be mistaken for *Pyrausta nubilalis*.

In the search for all the hosts of the corn borer a great many plants were examined upon which this insect was not found. Of these, the

[3] The pupal exuviae remaining in the injured plants are evidence that the insects passed through to the adult stage in the plants.

[4] This bulletin treats corn as one host. If the four horticultural types, dent, flint, pop, and sweet, were numbered separately, and pole and bush beans were considered as two, the total number of species and botanical and horticultural varieties known to have been infested in New England would be 221.

plants which have been examined most frequently and in the largest numbers are Antirrhinum, begonia, carnation, carrot, cyclamen, flowering maple (*Abutilon* spp.), fuchsia, hydrangea, iris, peony, petunia, perennial phlox, salpiglossis, *Scirpus cyperinus;* and, at the experiment field, alfalfa, flax, rye, sweet potato, upland rice, velvet bean, and vetch.

A few plants found infested when inclosed with borers can not be considered hosts. In cage experiments larvae were found feeding on bluegrass (*Poa pratensis* L.), carrot, Japanese iris, radish, and eulalia. Begonia plants growing in a window box in the laboratory were infested by small larvae, which soon abandoned them.

Of the European host plants (*4*) that occur in this section all have been found infested except *Phragmites communis* Trin. This plant occurs in two widely separated colonies, both in locations where the borers were extremely abundant. Of the hosts found in the Lake Erie region and Canada (*4*), all those that commonly occur in eastern Massachusetts are infested except mullein (*Verbascum thapsus* L.) and tumbling pigweed (*Amaranthus graecizans* L.).

A little less than half of the plants upon which the insect has been found are ordinarily cultivated. The remainder are either weeds, garden escapes, or wild plants. The more preferred hosts are also about equally divided between the cultivated and the wild plants. Several of the hosts occur within the infested area both as cultivated plants and as weeds and must be classed in both groups.[5] Hemp, Japanese hop, and white sweet clover, while cultivated in some parts of the country, occur here almost always as weeds on dumps and in other neglected spots. The small grains are seldom sown, but occasional plants, especially of oat, are found in waste places.

CULTIVATED CROPS THAT HAVE BEEN FOUND SERIOUSLY INJURED BY THE CORN BORER IN EASTERN NEW ENGLAND

The European corn borer has been found causing serious injury to the following cultivated plants which are occasionally or frequently grown in the infested area of eastern New England: Apple (windfall fruit), bean, beet, cauliflower,[6] celery, corn, eggplant, Japanese millet, mangel, pepper, potato, rhubarb, sunflower, Swiss chard, and tomato; and, among flowers, China aster, calendula, canna, celosia,[6] chrysanthemum, coleus,[6] cosmos, dahlia, gladiolus, golden glow, helichrysum, hollyhock, marigold, pansy,[6] prince's-plume (*Polygonum orientale*), salvia, and zinnia.

Although during years of extreme abundance of the insect and within areas of heavy infestation severe injury has occurred on all of these plants, over the infested area in general and in normal years this insect can be considered a pest on corn only. A yearly survey of the infestation of some of the more common host plants which are grown commercially has been made. (Table 1.) A few surveys have been made on some of the other crop plants, but most of the information on these is derived from miscellaneous notes.

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[5] The more important of these are sunflowers, Jerusalem artichoke, *Polygonum sieboldii* De Vriese and *P. orientale* L., native asters, and horse-radish.

[6] Found infested on only one occasion and then evidently by migrating larvae from near-by heavily infested corn.

TABLE 1.—*Annual survey of the infestation of some of the more important economic host plants of the European corn borer* [1]

Plant	Generation of borer	Year	Number of locations	Actual counts				Estimated figures		
				Plants examined	Examined plants infested	Average larvae per infested plant	Larvae per 100 plants	Area surveyed	Infested plants per acre [2]	Larvae per acre [2]
				Number	*Per cent*	*Number*	*Number*	*Acres*	*Number*	*Number*
Bean	First	1922	10	2,700	3.6	1.1	4.0	10.0	1,400	2,000
		1923	11	4,350	1.7	1.0	1.7	15.0	850	850
		1924	6	3,000	.3	.6	.2	5.0	150	90
		1925	8	8,000	.1	.7	.1	5.3	30	55
		1926	11	9,000	.2	1.0	.2	5.7	100	100
		1927	9	9,000	.1	1.0	.1	6.7	50	30
Beet	First	1922	9	1,900	20.3	1.1	22.3	8.2	20,000	22,000
		1923	16	2,900	19.2	1.3	25.0	9.5	19,000	25,000
		1924	10	2,000	4.5	.8	3.6	7.8	4,500	3,600
		1925	15	11,000	3.1	.6	1.9	6.5	3,100	1,860
		1926	10	7,000	3.5	1.0	3.5	2.7	3,500	3,500
		1927	8	7,500	.5	1.0	.5	2.3	500	300
	Second	1922	5	600	33.5	2.1	70.4	4.4	34,000	71,000
		1923	10	1,000	5.3	1.0	5.3	4.6	5,300	5,300
Celery	First	1923	9	4,700	.4	.8	.3	7.5	100	80
		1925	4	4,000	.1	1.0	.1	4.2	7	7
		1926	5	3,500	.2	.7	.1	4.4	50	35
		1927	7	7,000	.1	1.0	.1	2.7	1	1
	Second	1922	12	6,000	10.5	.8	8.4	32.0	2,600	2,100
		1923	9	4,500	6.9	.6	4.1	10.0	1,700	1,000
		1924	9	4,500	1.0	.4	.4	5.3	250	100
		1925	9	6,000	2.0	.3	.6	28.0	500	150
		1926	9	7,500	2.6	1.0	2.6	24.0	650	650
		1927	8	7,500	.2	1.1	.2	12.6	50	55
Dahlia [3]	First	1921	22	1,765	5.9	1.5	8.9	1.1	300	450
		1924	9	1,200	.7	1.1	.8	6.3	35	39
		1925	9	3,300	.2	1.0	.2	6.9	10	10
		1926	10	3,400	.5	1.2	.6	7.2	25	30
		1927	8	2,000	.5	1.1	.6	5.5	25	28
	Second	1923	10	670	22.8	3.7	84.4	1.7	1,100	4,000
		1924	9	1,300	1.1	2.1	2.3	6.3	35	120
		1925	10	1,800	9.5	2.1	20.0	7.0	680	1,040
		1926	10	1,600	4.8	2.3	11.0	7.2	240	500
		1927	8	2,400	3.3	1.4	4.6	6.2	165	230
Sweet corn	First and second.	1922	50	5,000	56.6	.....	.....	64.0	9,000	.....
		1923	66	6,600	32.0	.....	.....	57.0	5,100	.....
		1924	53	5,300	7.3	.....	.....	44.0	1,200	.....
		1925	61	8,700	13.5	2.5	33.8	68.0	2,200	5,500
		1926	41	5,200	18.0	1.4	25.2	50.0	2,800	4,100
		1927	28	3,600	11.6	1.2	13.9	45.0	1,900	2,300

Plant	Generation of borer	Year	Number of locations	Actual counts				Estimated figures		
				Plants examined	Examined plants infested	Average larvae per infested plant	Larvae per 100 plants	Total plants in survey	Total infested plants	Total larvae
				Number	*Per cent*	*Number*	*Number*	*Number*	*Number*	*Number*
Chrysanthemum [4]	Second	1922	30	124,500	1.1	0.1	0.1	350,000	3,900	390
		1923	19	90,800	.4	.4	.2	200,000	800	320
		1924	4	20,000	.1	.2	.1	64,000	16	3
		1925	4	30,000	.0	.0	.0	70,000	0	0
		1926	7	7,000	.3	1.0	.3	79,000	240	240
		1927	5	8,000	.0	.0	.0	38,000	0	0

[1] This table has been compiled from miscellaneous surveys not originally planned to be so tabulated; for this reason the data on sweet corn are incomplete. The number of plants examined in a location ran from 100 in some of the cornfields to 1,000 in some of the beet plantings, the varying number depending on the kind of plants examined and the intensity of infestation. A larger number of plants were examined in places of light infestation. Frequently every plant in the house was examined in the case of chrysanthemum.

[2] The figures in these columns are extensions in round numbers of the results obtained by actual count over a part of the area. They represent the actual infestation only if the entire areas surveyed were uniformly infested. The estimated planting rates per acre used here are beans, 50,000; beets, 100,000; celery, 25,000; dahlias, 5,000; and sweet corn, 16,000. These figures are based on field counts and on estimates by market gardeners of this section. Because of the nature of these surveys it is not consistent to carry the estimates to more than two significant figures.

[3] The "larvae per plant" is not always an actual count, because in some places the owners did not allow the plants to be cut; in such cases an estimate is used. The dahlia survey includes a few small home gardens; these are usually more severely infested than the commercial plantings.

[4] The percentage of infestation in chrysanthemum is larger than these figures show because many of the infested plants were removed by the grower before the examinations were made.

The economic loss due to infestation comes not only from a damaged or destroyed product but also from reduced crops resulting from injury to the plant, reduction in market area and price because of quarantine restrictions, and greater cost of production because of clean-up requirements.

The loss in sweet corn is caused both by a reduced yield due to stalk injury and by the fact that the ears are actually damaged or rendered unsightly by direct injury. This loss is negligible except in fields where there is considerable infestation; in severely infested fields sometimes the entire yield is unmarketable.

Only a very few bean pods were found infested in commercial plantings. Most of the infestation in celery was in the outer stalks that are always removed before marketing. The injury to beet was almost always restricted to a few leaf stems that could be removed when the product was sold as bunch beets. Later in the season when the beets had become larger and were sold by weight all the leaves were removed, so only those very few that were infested in the "beet" were unmarketable. Rhubarb, for the most part, is marketed early, before the insects can start to work in it; this is also true of spinach, which otherwise might be included with the more important host plants. Potato, although frequently infested in the vines, probably suffers little reduction in yield, as the vines are seldom noticeably injured.

Considering the number of borers involved, chrysanthemum doubtless suffers the greatest loss; a single borer, traveling from plant to plant, frequently destroys several buds or blooms before it is discovered and killed. The loss on chrysanthemum is kept down, however, because of the protection against moths and migrating larvae afforded by the houses when ventilating windows are properly screened, and because of the closer watch kept over the plants. The dahlia is usually raised commercially for the tuberous roots; these suffer practically no reduction in number or quality except when the plant is severely injured. Gladiolus, like chrysanthemum, is usually ruined when attacked. The number of plants destroyed in the larger commercial plantings is negligible; in smaller plantings and home gardens the injury is sometimes considerable. The remaining cultivated plants are either grown mostly in home gardens, or, if grown commercially in large plantings, are rarely injured to an economic extent.

Injury by the corn borer is not extensive in greenhouses; in fact, except in a few badly infested houses of chrysanthemums, this insect is negligible as a greenhouse pest. Chrysanthemum is the only plant growing inside which has been found frequently attacked, and it is the only one upon which economic loss has occurred. The softer-stemmed varieties have been those most severely injured, and much of the infestation was probably acquired while the plants were outside during the summer. Some growers assert that they have had little or no infestation when plants were kept in the houses throughout the year.

A few other greenhouse plants have been attacked. Stevia is sometimes infested and on several occasions has been rather badly injured. Other plants occasionally infested are the large stock

plants of geranium which have been outside during the summer, and the fruits of false Jerusalem cherry. Typical corn-borer injury has been found in heliotrope, and once a few larvae were found. Calendula was found infested only on one occasion, when five larvae were observed. Cucumber, spinach, tomato, coleus, mignonette, and rose—all hosts of the borer—examined in greenhouses had not been attacked, although rose has been reported as infested by one of the large-scale commercial growers.

CROPS NOT COMMONLY GROWN IN EASTERN MASSACHUSETTS BUT ON WHICH THE BORER IS A POTENTIAL PEST

A number of the plants listed as hosts of the borer have been found only as occasional weeds and garden escapes in waste places, or grown only occasionally or as experiments, but are more or less common crop plants in other parts of the country. These are the small grains, the millets, and buckwheat; the grain and sirup sorghums; broomcorn, Johnson grass, Sudan grass, and teosinte; cotton, tobacco, peanut, soy bean, cowpea, okra, white sweet clover, hemp, and hop. The following plants have been tested but not found infested: Alfalfa, flax, rye, sweet potato, upland rice, and velvet bean.

The infestation in barley, oat, rye, and wheat has usually affected less than 1 per cent of the plants. Hungarian, pearl, and golden millets were found very slightly infested, whereas European millet (*Panicum miliaceum*) and Japanese millet (*Echinochloa crusgalli edulis*) were frequently, sometimes rather severely, injured. European millet breaks over badly when infested, so the damage is greater than in other small grains.

All the sorghums, including broomcorn, have been commonly infested some years and have shown some infestation every year. Even when the number of infested stalks approached or reached 100 per cent, the number of larvae per plant remained low, and the injury to plant tissue was small, so the reduction in yield due to plant injury was slight. The actual feeding on grain was negligible.

Cotton was infested in the several years and in the four different experimental fields where it has been grown. It is difficult to obtain good-sized plants in New England; in one year only were large bolls obtained, and these did not fully ripen. Most of the infestation has occurred, therefore, in the stems. As a rule the tunnels are short and are frequently abandoned by the insect. In one plot about 200 fairly well-grown bolls were examined, 18 of which were infested. Several of these were dissected and were found to contain larvae feeding on the developing cotton fiber. (Fig. 2.) The larvae were full grown and apparently normal.

Peanut plants were attacked rather freely in the stems, but most of the larvae soon left them. Tobacco has been found infested, but no larvae have been found to remain or do any extensive feeding in this plant. Johnson grass, Sudan grass, and teosinte were only lightly attacked, even when other hosts near by were severely injured. Hemp and hop are found within the infested area of New England rather infrequently, but are usually severely attacked by the borers.

Although the extent of infestation in plants grown under experimental conditions may not be normal, it is at least indicative of the plants' susceptibility. (Table 2.) All stages of the insect have been found on most of the plants discussed in this section. Although many of them appear to be preferred by the insect, it must be noted that these plants were all growing beside badly infested corn and in very small plots. Host plants of the European corn borer are generally more severely infested under such conditions. Although several

FIG. 2.—Cotton bolls infested by the European corn borer. Larvae feeding upon the developing fiber

of these plants may become important hosts should the borer reach parts of the country where they are commonly grown, there is no certainty that such will be the case.[7] It does appear, however, that those plants which have shown little or no attraction for the borer, such as alfalfa, cowpea, flax, soybean, sweet potato, white sweet clover, teosinte, tobacco, upland rice, and velvet bean, are unlikely to be seriously injured.

[7] This bulletin deals strictly with a study of the corn borer in its two-generation development as it occurs in New England. The one-generation strain occurring in the more western infestations may have, and at present apparently does have, different food-plant habits. The difference in the insect's seasonal development may affect its reaction to these plants.

TABLE 2.—*Corn-borer infestation in field experiments of crop plants not commonly grown in eastern Massachusetts*[1]

Crop	Year	Plants examined	Plants infested	[illegible]	[illegible]
		Number	Per cent	Per cent	
Sorghums, etc.:					
Feterita	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hegari	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Kafir	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Milo	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sorgo (saccharine sorghum)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Broomcorn	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Johnson grass	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sudan grass	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Teosinte	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Millets:					
European	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Golden	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Hungarian	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Japanese	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pearl	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Small grains, etc.:					
Barley	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Buckwheat	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Oat	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Wheat	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Miscellaneous:					
Cotton	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cowpea	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Peanut	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Soybean	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[1] [illegible] Woburn, Mass. Alfalfa [illegible] and tobacco have [illegible]

[2] [illegible]

[3] [illegible]

[4] [illegible]

PLANTS AND PLANT PARTS IN WHICH THE INSECT MAY BE CARRIED

All host plants or plant parts which enter commerce, or are carried by automobile parties, and flowers carried in funerals or worn on the clothing, may bear the eggs, larvae, or pupae of the insect into uninfested territory. The partly or fully grown larvae cause injury which is ordinarily conspicuous, but to detect the small larvae hidden in stems or flowers (fig. 3), or between the husks and in the silk of the corn (fig. 4), and the egg masses on the underside of leaves (fig. 5), much care is required.

The hosts most likely to carry the borer are sweet corn (fig. 24), and vegetables such as green beans (fig. 25), bunch beets, celery

(fig. 17), peppers, and, more rarely, eggplants, rhubarb (fig. 20), spinach, and tomatoes (fig. 29).

Cut flowers, especially those with which a part of the plant is included, as chrysanthemum (figs. 26 and 27), dahlia (fig. 31), gladiolus (fig. 28), helichrysum, and zinnia (fig. 3), are also a source of danger. Some flowers borne on long slender petioles are seldom picked with a part of the plant and are less likely, therefore, to contain borers. Notable among these are cosmos, golden glow, and scabiosa. Ageratum, boltonia, celosia, heliotrope, marigold, native aster, pansy, and stevia, though less frequently infested, may contain borers.

The whole plant is sometimes carried. This is especially true of aster, canna, coleus, cosmos, geranium, heliotrope, hollyhock, false Jerusalem cherry, pansy, pompon chrysanthemum, rose, salvia, and tomato. Most of these, excepting potted chrysanthemum and false Jerusalem cherry, are moved in the spring, a time when there is little chance of their being infested.

FIG. 5.—Egg masses of the European corn borer on lower leaves

Although some of the vegetables, flowers, and plants here considered are not handled in the wholesale markets, they are all sold locally and often carried considerable distances. This is especially true of those sold at the stands along main roads.

The grasses, clovers (fig. 6), small grains, and buckwheat have been found infested mostly in uncultivated places or at the experiment field. It is more or less doubtful whether these plants can be

found as hosts when growing in any considerable stands and away from an environment of extreme infestation. Since most of these plants have been known to be hosts, it is expedient, nevertheless, to be on the safe side and consider any hay or straw originating within

FIG. 6.—Stems of clover infested by migrant larvae from near-by sweet [illegible]. Notice the frass in the lower crotch of the stem on the right.

the infested area as a possible carrier of the pest. The fact that dock, aster, goldenrod and a few other plants likely to be infested frequently grow in places where hay is made, makes this precaution even more needful.

HOST PLANTS FROM THE CLEAN-UP STANDPOINT

Corn, not only because it is so frequently and widely infested as compared with other host plants, but also because it is ideally adapted to the use of the insect as a place of hibernation, is the principal plant to consider in any clean-up work. This plant is of special importance in this regard because of the large size of the stalk, which even when broken into sections still offers ample protection to the insect, and because of the custom of cutting the plants several inches above the soil, thus leaving stubble which very frequently harbors some and occasionally a great many borers. (Fig. 7.) Borers have been found

FIG. 7.—Corn stubble infested by the European corn borer, showing one [illegible] larvae sometimes go

in sections of cornstalks in manure about to be spread on the land in the spring, and they are rather commonly found in stalks of corn lying on or near the surface of the soil in places where they were poorly turned under the previous season.

Dahlia, aster, and other cultivated plants have been found carrying the borer through the winter. Trash from the garden, especially corn and flower stalks, is frequently carried to dumps or left in other out-of-the-way places and becomes a source of reinfestation. In fact, it seems likely that such refuse may be the source of the severe infestations which have been observed in the plant growth on city dumping grounds. (Figs. 8 and 9.)

[illegible]

[illegible]

FIG. 16.—Plant of barnyard grass infested by the European corn borer. This plant was growing in the midst of infested corn.

The weeds, garden escapes, and wild plants growing upon dumps and in other waste places, or associated with cultivated crops, include some of the most frequently and severely infested host plants. (Fig. 10.) These plants, being neither of economic nor of quarantine importance, are of interest only as supporters of the pest. They are immediate sources of reinfestation to corn and other crop plants, and the larger weed areas serve as breeding grounds where the number of borers in a locality may be increased manyfold. This has happened in those great areas of mixed weeds in Arlington, Mass., and surrounding towns which in some years have harbored hundreds of thousands of borers (*4*, *3*). (Fig. 11.)[8]

Nor, when considering clean-up measures, should the damage from weeds on the borders of fields, along roadsides, walks, and fences, or

FIG. 11.—Mixed weed growth, mostly barnyard grass and pigweed, on land formerly cultivated. This area averaged 84 larvae of the European corn borer per square yard in 1922 (3, p. [illegible]).

in other neglected places be overlooked even when they are few in number and lightly attacked. Cocklebur and knotweed (Polygonum) growing on the banks of streams or other bodies of water have frequently been found infested. These plants are sometimes broken off or uprooted by high water and carried to other places. (Figs. 12 and 13.)

The noncultivated host plants most frequently and badly infested are ragweed, pigweed (*Amaranthus retroflexus*), knotweed, cocklebur, barnyard grass, dock, and hemp. Of these the first three mentioned are the most widely distributed as host plants. (Table 3.) Others occasionally or frequently found infested, sometimes very severely injured, are burdock, beggar-tick, datura, fireweed (*Erechtites hieracifolia*), hop, horseweed (*Erigeron canadensis*), nettle, panic grass, Mexican tea (*Chenopodium ambrosioides*), and wormwood (mostly *Artemisia vulgaris* and *A. biennis*). (Table 4.)

[8] No large weed areas in New England were found heavily and generally infested during the period from 1922 to 1925.

Fig. 12.—[illegible] water, and parts of them have been carried farther down the river.

[illegible] See Figure 12.

TABLE [illegible].—Yearly record of infestation in three of the most important weed hosts of the European corn borer

Weed	Year	Towns	Lots found	Plants examined	Plants infested	Total larvae
		Number	Number	Number	Percent	Number
Barnyard grass [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	1922	41	60	2,[illegible]	9	[illegible]
Do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do	1924	36	44	2,[illegible]	1	[illegible]
Pigweed (Amaranthus)	1921	11	14	270	9	44
Do	1922	16	16	[illegible]	[illegible]	[illegible]
Do	1923	28	62	1,[illegible]	6	[illegible]
Do	1924	11	12	[illegible]	[illegible]	[illegible]
Knotweed (Polygonum)	1921	10	14	220	27	[illegible]
Do	1922	10	11	136	21	70
Do	1923	11	11	[illegible]	[illegible]	[illegible]

[1] Echinochloa, Amaranthus, and Polygonum are the [illegible] most likely to be [illegible]

Although not so frequently, and seldom severely infested, there is some danger from goldenrod, lamb's-quarters, native asters, sow thistle, sunflower, tansy, yarrow, and the smaller grasses.

Hemp, giant ragweed, false ragweed, and velvetleaf (*Abutilon theophrasti*) are all susceptible plants and may eventually become very important hosts in localities where they commonly occur. It is possible that others rarely serving as hosts may belong to this group.

The remaining weed hosts are so infrequently infested that, except possibly in small isolated areas of infestation such as islands and small cultivated areas surrounded by forest, where it is conceivable that the corn borer may be eradicated, they are of no importance in clean-up work.

PARTS OF PLANTS ATTACKED AND NATURE OF INJURY

The corn borer may attack a plant in any part, that is, leaves, stems, roots, flowers, or fruits. The leaf blades are not fed upon except by the very small larvae, but the ribs and petioles of the larger leaves are often freely used as food. With most plants the injury is solely, or chiefly, in the stems. Roots are rarely infested, the fibrous roots never. Certain flowers and fruits are quite frequently attacked. Most plants attacked in the roots or in the flowers and fruits are also infested in the stems or leaf petioles. Corn is the only plant which is commonly infested in all parts.

LEAF INJURY

The eggs are usually laid on the leaves. (Fig. 5.) Since the young larvae often begin feeding at once on the plant tissue first at hand, it is probable that most plants (except those which may be repellent) upon which eggs have been laid have shown some leaf feeding. This feeding is usually very limited, but in a few kinds of plants may be rather extensive. In the column (Table 8) showing leaf feeding, only those plants are listed upon which considerable feeding in the midrib, petiole, or sheath of the leaves has occurred. (Figs. 17 and 20.) The plants in which these parts of the leaf were eaten most frequently or extensively are corn, the sorghums, tomato, the small grains and grasses, beet, mangel, Swiss chard, celery, rhubarb, gladiolus, canna, and hollyhock.

The injury to the leaf blades by the newly hatched larvae consists of minute holes, either roundish, linear, or irregular in outline, through the leaf, or in some cases only partly through the leaf, leaving intact the epidermis of one side. (Figs. 14 and 15.) Larger

FIG. 14.—Injury to corn blades by the young larvae. Note [illegible] areas do not extend entirely through the leaf. These appear as white areas in this picture.

larvae sometimes make holes (often rows of holes, similar to those made by Papaipema) through the leaf blades of corn while the leaves are still rolled in the growing tip of the plant. (Fig. 16.) Injury to the leaf blades is usually accompanied by scanty or no frass and often can not be distinguished from injury by other insects.

The young larvae tunneling in the midribs of leaves are often as well concealed as are larger larvae in the main stems. When feeding occurs in the midrib the leaf usually breaks at the point of worst injury. This is especially true of corn and the sorghums, in which the leaf ribs are usually entered rather close to the stalks.

In the grasslike plants, including corn and sorghum, the injury to the blade and midrib is usually accompanied by infestation in the leaf sheath. The larvae feed on the inner side of the leaf sheaths and sometimes on the proximate part of the stem, and in that case the space between sheath and stem contains more or less of the characteristic frass. The injury to leaf petioles is very similar to injury to the main stems of the plants, except that the frass is more likely to be discolored or sticky from the plant juices. The larvae do not always tunnel into celery petioles. They are sometimes found feeding on the surface of the small inner leaf stems, more or less protected by the outer leaves, or more frequently feeding within the groove of the leaf stem, often protected by a slight webbing of silk, sometimes mixed with frass. (Fig. 17.)

Fig. 17.—Leaf feeding on celery by a nearly full-grown European corn borer larva. [illegible]

STEM INJURY AND APPEARANCE OF FRASS

By far the greater number of plants are infested in the principal stems, variously called stems, stalks, branches, culms, canes, and vines. With the exception of plants like celery, which as ordinarily grown consist only of leaves, most of the larvae, whether feeding on parts of the leaf or not, eventually reach either the branches or the main stalk of the plant. Sometimes they enter the stems through the leaf petioles, but more often by traveling on the surface of the plant. Migrating larvae usually attack the main stem first. Stems are most frequently entered near the junction of the leaf petiole, but may be attacked anywhere from the base of the plant to the growing tip. In the sorghums the stem injury is almost always close to or even within the seed head.

Feeding in the stems is chiefly confined to the pith. In the majority of infested plants the tissue consumed is only a small proportion of the total pith cells of the plant. In some of the favorite hosts, however, the greater part of the interior of the plant is sometimes destroyed. This occasionally happens in the case of corn, aster, gladiolus, pigweed, cocklebur, beggar-ticks, dock, hemp, and knotweed. It is difficult to determine the extent of feeding in dahlia, most grasses, small grains, buckwheat, and a few other plants because the stems are naturally hollow. In these plants the larvae feed chiefly upon the lining of the tube which constitutes the stem.

The appearance of the injury, the size and shape of the tunnels, and the size and general appearance of the particles of frass are characteristic. The stems of most small plants, and frequently of corn and other large plants, are likely to break at the point of most severe injury, making the infestation still more conspicuous. As a rule that part of the plant above the injury is not killed outright, but often, especially in tender growth, it soon wilts and dies. This is especially true of aster, chrysanthemum, geranium (fig. 18), gladiolus, and all plants with small succulent stems, as portulaca and galinsoga. In cases where the plant does not wilt, or where the frass ejected from the entrance hole is scattered, the infestation is frequently difficult of detection. Such infested plants are often detected by the swollen condition of the stems at the points where they were entered by the larvae. Examples of these are cocklebur, hemp, Polygonum, and ragweed. These swellings in Polygonum are tinged with red.

Ordinarily the extruded frass remains in little bunches, a third of an inch or less in diameter, close to the entrance hole or lodged in a crotch of the plant (fig. 19); though sometimes it is dry like sawdust and falls directly to the ground. Much of it remains within the larval tunnel or the hollow stem of the plant.

The frass [9] of the corn borer is smaller in size than that of the corn ear worm but larger than that of most of the small lepidopterous borers and sawfly larvae frequently found in the same plants. The color varies from almost white to gray or dark brown, depending upon the plant and exposure to the weather. Occasionally it is given unusual colors by the plant attacked, as green from the succulent green stems of tomato and geranium, salmon pink from the ripe fruits of tomato, bright to dark purplish red in sorghum stems, and black in the leaf petioles of beet and Swiss chard. As a rule the frass is comparatively dry, falling apart at the slightest touch, but in some plants it is bound together rather firmly by the juice of the plant, as in beet, mangel, Swiss chard, and rhubarb. In rhubarb the frass is practically indistinguishable in the jellied or gummy mass which fills up the excavations and oozes out of the entrances or exit holes. (Fig. 20.)

ROOT INJURY

The roots of plants are rarely, the fibrous roots never, attacked. Larvae have been found working in the main taproot of cocklebur, and brace roots of corn have been found infested. Beet and mangel

[9] This should not be confused with the particles of plant tissue cut out by the borer in excavating but not passed through its body. [illegible] smaller than the pellets of frass, flaky, and under a lens show the unaltered cellular structure of the tissue.

FIG. 13.—Geranium stem infested by the European corn borer. Note the wilted leaves that are typical of many injured plants, especially the

FIG. 19.—[illegible] infested by the European corn borer. Typical appearance of the [illegible]

are occasionally found infested in the fleshy, enlarged taproot which forms the edible portion of these vegetables. Although such injury is in most cases confined to the part close to the crown of the plant, the larvae sometimes tunnel all through the beet. Exit holes, or possibly attempts at exit holes, have been found several inches below the surface of the soil. (Fig. 21.)

Note tunnel to the outside of the beet below the surface of the soil.

Root infestation, with the exception of attacks on the brace roots of corn, which is extremely rare in New England, has always been accomplished by larvae working down through the main stalk or from the petioles of basal leaves. If that part of the main stalk below the highest lateral roots, and often surrounded with soil, be considered a part of the root system, it can be said that the borer works in the roots of corn. (Fig. 7.) It has also been found in the corresponding part of the stems of barnyard grass.

FLOWER AND FRUIT INJURY

A few plants have been found infested in the flowers, or in the seeds or fruits, and some in all of these parts. The flowers infested are, with few exceptions, those which are closely or directly attached to the main stalk of the plant, the stem of the flower in some cases being a continuation of the principal plant stalk. (Fig. 22.) Infestation in the fruits and seeds has resulted either from previous flower infestation or from attacks on the fleshy fruits by large migrating larvae.

Corn is infested in the tassel and in all parts of the ear. The young larvae seem to prefer the pollen and silk when these are fresh. The larvae attacking the tassel may feed on or in the unopened pistillate flowers for several days before entering the rhachis or the stalk. (Fig. 23.) Larvae frequently become full grown while feeding on the silk alone, but most of those that hatch on or find their way to the ear soon enter it and either feed on the unripe grain or work into

the center of the ear. (Fig. 24.) Unlike the corn ear worm (*Heliothis phloxiphaga* Fab.), they may enter the ear anywhere—at the tip, the side, or the butt, or through the shank. A larva attacking the grain may feed on from one to a dozen or more adjacent kernels. Sometimes a larva eats a single kernel and passes on to the cob. In extreme infestations a number of larvae in an immature ear will consume the greater part of the kernels, but hardened grain is usually only slightly injured.

Hemp and the grain sorghums are sometimes infested in the flower head and in the resulting seed. Apparently some larvae spend their whole existence working among the branches of these heads, feeding

FIG. 22.—Aster flowers containing larvae which have worked up through the stems. The flower on the left shows a larva feeding on the receptacle and ripening seeds. The flower on the right shows the withered head near the base of the flower, and wilted petals.

upon the developing grain while more or less protected from weather and enemies by this type of inflorescence.

On one occasion, when sunflowers were planted with corn as a silage crop, the flowers were freely infested. The larvae were found feeding mainly in the hollow petioles, in the receptacles of the flowers, and on the developing seeds. Late-planted beans are frequently infested in the pods by second-generation larvae, the feeding being done on both the lining of the pods and the beans. (Fig. 16.) A number of larvae have been found boring upon the partly developed fiber in cotton bolls. (Fig. 2.) In one instance, a seed pod of Datura was found infested; and flowers, seed pods, and seeds of cocklebur are sometimes attacked.

The flowers of amaranthus, China aster, celosia, chrysanthemum, dahlia, gladiolus, marigold, and zinnia are sometimes attacked.

In the dahlia a considerable reduction in the number of blooms is brought about by the newly hatched larvae crawling from the leaves where the eggs were laid to the growing tips of the plants and there entering through the buds and tender stems, and eggs laid on the blooms have sometimes caused the flowers to be infested by larvae. In many cases the blooms of dahlias, like those of the other infested composites, such as aster, chrysanthemum, marigold, sunflower, and zinnia, are invaded by small larvae working up through the stem of the flower. The larvae first feed within the petioles, then bore through the receptacle of the flower, and finally feed on the developing seeds and the lower parts of the florets. The injury to the flower is often inconspicuous. It may be detected by the presence of frass or sometimes by a few wilted or dried-up florets. An occasional flower may fail to develop symmetrically. (Fig. 26.) Chrysanthemum flowers are more likely to be destroyed because of injury at a lower point in the plant, which causes the flower stems to break or the flowers and buds to wilt. Frequently the point of injury is so high in the stem that it spoils the specimen as a cut flower even though the injury has occurred too late to prevent the production of a perfect bloom. (Fig. 27.)

Fig. 28.—[illegible]

The flowers of gladiolus are occasionally entered by borers, which eat through the petioles and feed on the lower parts of the petals and on the undeveloped seeds. The greatest injury to these flowers, as with chrysanthemum, is caused by the larvae feeding in the stems. (Fig. 28.) The work of the larvae in the stems, depending on the stage of growth of the plant when attacked, may prevent a flower spike from developing, may cause the spike of buds to wilt and die, or may result in the flower spike breaking over, in any case ruining it for sale.

In the inflorescence of celosia and amaranthus the infestation is in that part of the stem to which the small flowers are attached. There are a number of other flowers which are sometimes destroyed as a

result of infestation in the stems or main part of the plant, although the bloom is not infested. The most important of these are agreatum, California poppy, helichrysum, heliotrope, monarda, stevia, prince's plume (*Polygonum orientale*), rudbeckia, salvia, and pansy. The rose has been found infested only a few times and then only in the more succulent plant stems. Cosmos and hollyhock, although occasionally infested, have rarely been sufficiently injured to reduce the quality or number of flowers.

Few fruits are attacked; those most frequently infested are tomatoes and peppers. Eggplants, squashes, cucumbers, Jerusalem cherries, ground cherries, windfall apples,[10] pears, and grapes have been known to be attacked. It is probable that most, if not all, infestation in fruits is caused by migrating larvae.

The larvae generally enter tomatoes and peppers near the petiole; from this point they work all through the fruit. In the pepper they feed on the lining of the seed cavity and the seeds. In the tomato they feed on the pulp and are often immersed in juice, but apparently are not inconvenienced and are perfectly normal. (Fig. 29.) The injury in these fruits when first attacked is not noticeable, but as the infestation advances the fruits collapse in places, become discolored, and are frequently infected by disease.

In apples, the larvae enter the fruit at any point and work freely through it. (Fig. 30.) Often several larvae enter the same apple and soon so thoroughly excavate it that no part is left intact. The frass, at first very light colored and moist, soon becomes brown and dries when exposed to the air. Injury to pears is very similar to that in apples.

FIG. 29.—Sweet corn showing typical injury by the European corn borer.

Bunches of grapes when infested are made extremely unsightly by the sticky, discolored frass and shriveled, infested grapes contained

[10] An apple, still on the tree, was also found infested.

FIG. 25.—Bean pods showing typical corn-borer infestation

[illegible]

over the sound fruit remaining on the bunch. Some of the larvae have been found inside grapes, submerged in the juice of the ripe fruit.

Eggplant, squash, and cucumber fruits have been rarely attacked, and the infestation has been confined to a small amount of excavation into the flesh. Larvae have been found working inside the fruits of false Jerusalem cherry and ground cherry.

The fleshy fruits have invariably been found infested late in the season by larvae which would not pupate until the following spring. Such fruits are not suitable as places of hibernation; in fact most of them soon disintegrate and fail the larvae both as sources of food and as places of shelter. There are, therefore, no records of the insect becoming adult in them.

FIG. 29.—European corn-borer larva feeding within a ripe tomato and the appearance of the injury from the outside.

THE SEASONAL CYCLE OF THE INSECT

GENERATIONS OF THE INSECT

All stages of the insect found on a plant are listed either under the first or the second generation in Table 8. Because of the fact that in some years there is only a partial second generation, it is impossible, after a certain time in the summer and until the end of the generation the following spring, to be certain whether an individual is a member of the second generation or belongs to a single-brooded phase of the insect. Larvae during this period are generally considered as of the second generation because of this uncertainty, and because in most places larvae of the second generation are in the majority.

Most of the plants listed as second-generation hosts are known to be so because they were found infested in years when the single generation was not known to occur (see p. 62) or at a time when the larvae could be readily distinguished from the large, full-grown, single-generation specimens.

The plants found infested by larvae of only one of the generations are usually either plants of rare occurrence or plants infrequently

attacked, most of the more common hosts are infested by both generations.

Many of the plants infested by both generations are much more frequently attacked by one than the other brood of larvae. The second generation attacks the larger number of plants, and by far the greater number of rarely infested plants have been found as hosts of this generation only. This is doubtless because the moths of the second generation are more numerous in normal years,[1] and more generally dispersed than those of the first, and because most of the plants are more suitable later in the season both for oviposition and for food.

There has never been any indication from general observations that the food preferences or feeding habits of the two generations differed; all apparent differences such as kinds, numbers, and parts of plants attacked, or nature of injury inflicted by each generation, are easily explained by the differences in development, age, and abundance of the plants, and the difference in numerical abundance of the insect in the two generations.

As here listed there are 25 kinds of plants upon which the first generation only has been found, 119 upon which the second generation only has been found, and 75 that are infested by both generations.

No special effort has been made to discover upon how many hosts a single generation occurs. It is found commonly on corn. Large first-generation larvae have been found late in August and early in September, after pupation had apparently ended, upon the following plants: Cocklebur, barnyard grass, panic grass, knotweed, and beggarticks. It is extremely doubtful if these larvae would pupate before the following spring; if they did not, they would be single-generation specimens.

[1] In corn during 1919 and 1920 the second generation was considerably smaller than the first.

STAGES OF THE INSECT ON EACH PLANT

In order to determine the host status of plants upon which borers have been found, an effort has been made to discover what stages of the insect occur on each plant, as shown in Table 8. In many of the plants it has been possible to follow the development of the borers through from eggs to adults, noting the several instars of the larvae. In others, although all life stages have been found, it is not known whether or not the early larval instars can subsist on them.

FIG. 3.—Egg mass of the European corn borer laid on a dahlia flower

The records of egg occurrence are the least complete. This is because eggs are present in the field for a shorter period than the larvae, the masses are not so numerous, and they are much more difficult to find. Many of the plants, however, have been examined for eggs, some of them rather extensively, and, as the tabulations show, eggs have been found on many of the more important host plants. The plants upon which eggs have been most frequently found are beet, corn, rhubarb, sorghum, dahlia, dock, knotweed, and cocklebur. Those which have been examined for eggs and upon which none, or very few, have been found are squash, tomato, gera-

mum, burdock, false ragweed (*Iva xanthifolia*), milkweed, ragweed, and sumac.

Probably a large proportion of the plants listed become infested by migrating larvae and are not found attractive or suitable for oviposition by the moths; only repeated examinations will prove this point.

Eggs are usually placed on the underside (fig. 30) but occasionally on the upper side of the leaves. They are sometimes found on the stalks of corn, cocklebur, and knotweed, and doubtless have occurred on the stems of other plants. On several occasions eggs have been found on the flowers of dahlia.[12] (Fig. 31.)

Eggs have not been found on fruits, but have been found on the modified leaf blades on the ears of corn.

The corn borer is most frequently found as a larva. This is because larvae are more abundant than egg masses or, because of larval mortality, than pupae; they are rather easily detected in the infested stems; and the insect passes the greater portion of its life cycle in the larval stage.

Except for the short time during which the newly hatched larvae are exposed, they are usually found within the stems of the plants. Occasionally they enter the roots (figs. 7 and 21) or the flowers and fruits of some of the hosts. Sometimes they remain in more or less exposed positions, as on grain-sorghum seed heads, corn silk (fig. 32), and protected parts of leaves.

The hibernating larvae are indicated separately in Table 8 to show which plants have successfully carried them through the winter. The plants in which hibernating larvae have been found in the spring are considerably fewer than those in which active larvae have been found in the fall, for the following reasons: It is impossible to determine the species of some of the plants after they have passed through the winter; most of the garden refuse and many of the weeds are cleaned up before they can be examined in the spring; and many of the plants do not offer suitable hibernating quarters. This last reason is especially true of beet, mangel, celery, rhubarb, Swiss chard, the small grains and grasses, and some of the more delicate and succulent garden flowers and weeds, as ageratum, portulaca, mignonette, atriplex, coltsfoot, galinsoga, and the mustards.

The pupae are likely to be found wherever the mature larvae have been feeding or hibernating, if these locations are suitable for pupation. Usually the larvae pupate within the tunnels in the stems of plants (fig. 33), but pupae are occasionally found on leaves or stems with no further protection than the strands of silk by which they are attached. Sometimes they have been found under the bark of apple trees, between boards, and in telephone and fence poles. The first-generation larvae are quite likely to pupate within the ears of early sweet corn, either between the kernels or in the cob. The number of plant species in which pupae occur is much smaller than that of those supporting larvae.

It seems most reasonable to assume that any plant which will bring the insect to a normal pupa has successfully carried it to ma-

[12] Eggs were found on dahlia flowers during the summer of [illegible], but have not been noted since. In that [illegible]

FIG. 32.—Larvae of the corn borer living in the silk of corn. This silk lay against the ear, affording good protection. This type of silk infestation is unusual, but the larvae are frequently found in fresh silk within the husks

tunity. For the sake of completeness, however, a column marked "adults" has been added for each generation (Table 3), showing in which plants the pupal exuviae (indicating that an adult has emerged) have been found.

The number of plants upon which each stage and those upon which all immature stages have been found are shown in Table 4.

Table 4.—Number of plants upon which the immature stages of the corn borer are known to have occurred [1]

Generation	Egg	Larva	Pupa	All three stages	Generation	Egg	Larva	Pupa	All three stages
First	35	80	52	19	Both	18	86	28	9
Second	[illegible]	[illegible]	[illegible]	[illegible]	Either	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

EFFECT OF SEASONAL DEVELOPMENT, CONDITION AND CHARACTERISTICS OF THE PLANT ON INFESTATION

Some plants, as already mentioned under "Generations of the Insect," are early and essentially first-generation hosts, whereas others usually come later in the season and are attacked by the second generation.[2] It is also obvious that the development and condition of plants at the time of egg laying and the subsequent larval feeding influence the frequency and intensity of infestation in them. It is equally true that the inherent characteristics of the plants will affect their susceptibility to attack by the insect.

DEVELOPMENT AND CONDITION OF PLANTS

Apparently one reason why many plants are not attacked by the first generation is that they are either too small or too immature to be attractive to the moths as places of oviposition. This is indicated by counts of first-generation eggs on corn planted on different dates, the number of egg masses per plant being greater with the increase in size and age of the plants. That the condition as well as the development of plants affects the rate of oviposition on them is shown by counts of second-generation eggs. In this case there is a decided increase in the number of eggs on the fresher, younger plants. The sizes of these plants are not recorded but must have been about the same for all plantings. While not all the series run as regularly as the one tabulated (Table 5), an average of a number of series shows even greater regularity.

Corn is the only plant upon which such detailed studies have been made. Observations on dock, however, seem to support this view. Dock is a favorite first-generation host early in the season, when it is more advanced, taller, and more leafy than the surrounding herbaceous vegetation; it is not so frequently infested by the second generation at a time when, for the most part, it is mature and becoming dry. It seems reasonable to believe that this same principle must hold true to a greater or less extent for all the host plants.

[2] [illegible]

TABLE 5.—*Comparative infestation of corn in relation to time of planting*[1]

Plot No.	Seed planted	Plants up	Examination for first generation: Date examined	[illegible]	[illegible]	Stalk infested by first generation: [illegible]	[illegible]	[illegible]	[illegible]	Examination for second generation: [illegible]	[illegible]	[illegible]	[illegible] at harvest: [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	Apr. 27	May 15	June 27	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	May 10	May 20	June 26	11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	May 25	June 1	do	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	June 6	June 17	do	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	June 26	July 3	do	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[1] [illegible]

[illegible]

[illegible]

Bean, beet, and spinach as commercial crops are usually grown early, the large plantings are harvested and cleared up before there are many larvae. Spinach is gathered even before the first-generation larvae, and the other plants before the second-generation larvae become numerous. Small home-garden plantings, however, of beans and beets have occasionally been severely infested late in the season. If these were generally planted late and were thus subject to infestation by the large numbers of the second generation, there would doubtless be serious economic loss on them at times. Some of the more important host plants generally developing later in the season are celery, tomato, pepper, sorghum, pigweed, and barnyard grass. These are rarely infested by the first generation of the borer.

In more or less pure stands of any weed there is a great variation in the size of individual plants, depending not on the time of germination but rather on the individual vigor and environment of each plant. Almost invariably it is the larger of these plants which are attacked, suggesting that it is size rather than maturity which makes them more susceptible. This condition is frequently seen in stands of ragweed, pigweed, knotweed, and hemp.

Sometimes larvae leave plants that afford inferior or inadequate protection for the winter and enter near-by plants, causing the latter to appear to be exceptionally favorite hosts. For example, in some of the areas of mixed weeds, barnyard grass is the principal food plant. Although many of the borers remain in this plant all winter, others migrate to the less common pigweed plants to such an extent that the latter are literally filled with the borers. Earlier in the season, when the pigweed plants were in a green and growing condition, they were not so attractive.

CHARACTERISTICS OF HOST PLANTS

As oviposition usually takes place on the leaves it is, naturally, affected by their size, shape, and texture. One of the plants upon which eggs have been frequently found is rhubarb. The leaves of this plant present an ideal location for oviposition as well as ample shelter for the moths. This is doubtless why rhubarb is so frequently infested, although the plant itself does not appear to be a good host for the borer. It will be noticed that most of the plants upon which eggs are frequently found have from medium sized to large, entire leaves, comparatively free from pubescence. Several of the commonly infested plants, as ragweed, tansy, wormwood, and cosmos, have finely divided leaves, which offer very small areas of continuous leaf surface. In no known case have eggs been found on these plants when grown in the open. In cage experiments eggs have been found on ragweed and tansy; under such conditions, however, the adults oviposit on almost any available surface. In a cage containing several plants each of ragweed and China aster, one egg mass was laid on the ragweed and six on the aster; in another cage of ragweed and bean, several egg masses were laid on the bean plants and none on the ragweed; in a cage of cosmos and gladiolus, none were placed on the cosmos, but seven masses were laid on the gladiolus. The sorghums and teosinte, which resemble corn in leaf and growth, appear to be used just as freely as corn for oviposition and in the same way.

That extent of surface is not the only attribute of the leaf which influences oviposition is shown in the case of burdock. The leaves

of this plant very much resemble those of rhubarb in size, shape, and position, and it is found growing in the same localities. This plant has been examined for eggs many times, but there is only one record of eggs found on it. This plant, nevertheless, has proved a better host of the borer than has rhubarb.[3]

Besides extent and nature of leaf surface, there are other characteristics of the plant which affect its relation to the borer. Since the moths seem to prefer the undersides of leaves for oviposition, it is likely that the upright position of the leaves of gladiolus accounts for the fact that so few eggs are found on this plant. Color attraction is indicated in the oviposition on dahlia blooms. Of the several hundred egg masses found on the flowers of this plant, most occurred on those of the dark-red and terra-cotta shades and very few on the white and yellow flowers. Whether or not there is a chemotropic attraction of the plants for the moths, or for migrating larvae, is now being investigated.

The nature of the stems, while probably not affecting oviposition, greatly controls the extent of infestation on and the degree of injury to the plant. Although the borer occasionally enters woody tissue, it is quite evident in studying its hosts that the more woody or harder stemmed plants are largely avoided. In cases where locust, sumac, blackberry, raspberry, or grape have been infested, or where bean and telephone poles or other pieces of wood have been entered, the boring has been done in most, if not all, cases by large migrating larvae seeking protection rather than food. Of herbaceous plants the harder and more wiry stemmed species and varieties are not so freely attacked as the thicker and softer stemmed ones. This is true even of plants in the same genus, or of varieties of the same species. For examples, *Aster puniceus* is much more frequently infested and more severely injured than is *A. cordifolius*, and among greenhouse chrysanthemums the softer-stemmed varieties are the more frequently infested. Most of the plants attacked are either annuals or herbaceous biennials and perennials. The stems may be either pithy or hollow, and a few of them are succulent.

The size of the stems is also a factor controlling the extent of infestation. Although larvae of early instars can tunnel in very small stems, and larger borers are sometimes found in stems so small that their bodies appear to be uncomfortably compressed, there must be a limit to the smallness of stems that can be used, and this is doubtless the reason why many of the smaller grasses and small species of such favorite genera as Polygonum are not infested. This probably also accounts for the fact that the larger individuals in a pure stand of a plant species are most often attacked.

The large number of very short abandoned tunnels observed in burdock, Lythrum, cotton, and less frequently in some other plants, indicates that these plants are at least not relished. In cage experiments and in the laboratory larvae have repeatedly refused to feed on larkspur, foxglove, German iris, sweet potato, and candytuft, and, after a trial, have left begonia, carnation, cabbage, carrot, and turnip. Eggs have been laid on some of these plants.

Many plants seem to be toxic to the insect. Tobacco is unquestionably toxic. Larvae found in this plant were either dead or un-

[3] Once one plant has been recorded in rhubarb, although the insect may [illegible] for pupae.

ally died soon after they were brought to the laboratory. The larvae after feeding a short time would darken and contract before dying. If not too far gone, however, they would recover if placed on corn. In cages moths freely lay eggs on tobacco plants. On emerging most of the young larvae die within a few hours after sampling the leaf; a few leave the plant without feeding on it. Petunia, a closely related plant, has the same reaction as tobacco on the newly hatched borers. The high mortality of larvae in some other plants, as pigweed and ragweed, would indicate that these plants did not prove an ideal food. Shepherd's purse and cudweed have each been found infested only on one occasion, and in both cases the larva was dead. In considering the possible toxic qualities of plants, it is interesting to note that the insects have passed through to the adult stage on tansy and Datura, both of which are very poisonous.

ENVIRONMENT AND DISTRIBUTION OF HOST PLANTS AS AFFECTING THEIR INFESTATION

Although an ecological study of the hosts of the corn borer is involved, and some of the problems have been investigated only superficially, there are certain points in the environment of the plants concerned which obviously affect their status as hosts of the borer. Because of the concentration of adults about corn and weed areas, which often share with corn the distinction of being foci of infestation, and because the larvae migrate freely in search of new food supplies or better protection, the proximity of other hosts to such spots markedly influences the extent of infestation in them. Most of the rarely infested hosts attacked have been found within relatively short distances of such sources of infestation.

MIGRATION

The relative frequency of infestation in plants, while in many cases resultant from oviposition, is to a great extent independent of where the eggs are laid, because of the migration of the larvae. Migration is of two distinct types, if the dispersion of newly hatched larvae after little or no feeding can be considered as one; the other is the movement of partly or fully grown larvae.

The newly hatched larvae, usually after a very limited feeding on the eggshells or on the leaf tissue, may travel or be borne to near-by plants. Careful observations have shown that larvae from one egg mass commonly scatter to several hills of corn. The same thing apparently happens in regard to other hosts. Very frequently several plants that are in contact, or close together, are found attacked, with no other infested plants near them, which suggests that only one egg mass was involved. This early dispersion of young larvae may account for the infestation that occurs in such hosts as tansy, ragweed, yarrow, and cosmos, plants which probably are not used for oviposition, although the migration of larger larvae accounts for it in many instances.

The true migration of partly or fully grown larvae seeking new or different food supplies, or better protection (especially for hibernation), is a common and general occurrence. (See p. 44.) Examinations for eggs on many kinds of plants in the experiment fields indicate that plants more severely infested than normally because of their proximity to corn are more likely to be infested by migrant

larvae from the corn than from an instance of oviposition induced by such an environment.

Although the status of the rarely infested plants in many cases is unknown, there is every reason to believe that some are infested by migrating larvae. A striking example of infestation through migration took place at the Medford experiment field in the fall of 1922. In that year the infestation was so heavy in the late plantings of sweet corn that the larvae consumed the edible portions of the plants, and hordes of them were forced from the broken-down plants by an urge for food and better protection. (Fig. 24.) A large number of trial plots of various vegetables, field crops, and flowers were located close to this corn. In these plots some kinds of plants—notably tomato, okra, coleus, pansy, and portulaca—sustained no infestation until this migration took place, and then they became freely infested by the full-grown larvae. The okra, although not infested until attacked by large migrating larvae, had been used rather freely by the moths for oviposition.

FIG. 24.—[illegible]

Another notable instance of migration recorded by Barber (*1*) occurred a little earlier in the same year on a farm in Winchester, Mass. A small, heavily infested patch of sweet corn had been poorly plowed under. As a result of this, or from other corn still standing near, there followed shortly a migration of borers to various plants growing beside a stone wall on one side and to grapes and windfall pears in a field on the other side. Through this migration the following plants were infested: Asparagus, *Aster cordifolius*, black raspberry (canes), goldenrod, grape (vines and fruit), milkweed, pokeweed, sumac (branches), and windfall pears. These are all plants that have been found infested either infrequently or only on this occasion. They comprised most of the nearby plants which were at all suitable to the borers, the remaining vegetation being chiefly short grass, trees, and underbrush.

Besides the large migrations of fully grown larvae from corn, examples of which have been cited, there is a more commonly occurring but less extensive migration of newly hatched and partly or fully grown larvae into plants closely associated with corn. The plants most commonly found infested were ragweed, polygonum, knotweed, and barnyard grass. Others occasionally infested in this way were purslane, which frequently carpets the soil after the last cultivation, some of the clovers and grasses, several species of Labiatae, and the common mallow. Although most of these infestations were probably caused by migrating larvae, in some cases the infestation resulted from oviposition. Eggs have been found rather frequently on polygonum when growing among corn.

WASTE AREAS

Certain waste areas in and near cities have been notable breeding places of the borer. There are two distinct types of these areas. One type consists of idle-land areas varying in size from a single building lot to many acres. The larger of these areas, when lower than the street level, are frequently used as city dumping grounds. Former market-garden sites recently given over to real-estate developments constitute the other type.

Areas of the former type are the more numerous, are frequently rather extensive, and often, except by the accession of ashes and other débris, remain undisturbed for years. The dumps offer a fertile field for many kinds of plants. This vegetation varies more or less in different places and on different parts of the same area. Often portions of the area have been so recently covered with ashes that little vegetation has started on them.

The weeds most frequently seen on these waste areas and dumps are burdock, tansy, chicory, and white sweet clover—all plants which are seldom severely infested. Scattered among these plants, and sometimes growing in rather good-sized pure stands, are cocklebur, coltsfoot, dock, panic grass, knotweed, ragweed, wormwood, and Mexican tea—all plants which are occasionally to frequently attacked. It is on these areas that garden escapes and volunteer and miscellaneous plants are commonly found infested. Those ordinarily found are potato, Jerusalem artichoke, buckwheat, the small grains, especially oat, sunflower, *Polygonum orientale* and *P. scandens*, Japanese hop, hemp, and false ragweed (*Iva xanthifolia*). Many of the rarer finds were also made in these places. The most commonly occurring plants are usually either biennials or perennials which hold their position for years. There is a tendency on the older dumps for the annual weeds to disappear. Whether or not the ravages of the corn borer on these plants have anything to do with this is not definitely known. There are, however, always a considerable number of the more susceptible plants (especially on the original level about the dumps), and in these are generally at least a few borers whose numbers are augmented from time to time by recruits brought in in garden refuse.

Owing to the expansion of the cities and the resulting rise in land values, hardly a season passes without one or more market gardens being abandoned to real-estate developments. Years sometimes elapse between the time when cultivation of this land ceases and the time when it becomes built up. At first this land becomes covered

with an extremely rank weed growth, fed by the accumulation of years of heavy fertilization. During the first few years this growth consists principally of annual weeds, mostly of the more tender and susceptible species. The most numerous of these are barnyard grass, pigweed (*Amaranthus retroflexus*), horseweed (*Erigeron canadensis*), and sometimes knotweed. (Fig. 11.) Most of these are highly susceptible to the borer, and it is in this stage of the growth of these areas that the immense larval populations occur. As these areas grow older, wild lettuce, sow thistle, dock, nettle, goldenrod, native aster, grasses, and others of the hardier weeds begin to come in, all of which are plants less likely to be infested. There may remain, however, many of the highly susceptible weeds and the area may still support many borers. Finally, especially with the aid of burning and herbicides, these areas become covered principally with grass and a few perennial weeds and cease to be a menace to the near-by gardens or breeding grounds from which moths may fly considerable distances to corn and other crops.

ABUNDANCE AND CONTINUITY OF HOSTS

The abundance and continuity of plant species would seem to be an important line of investigation in studying the intensity and relative frequency of their infestation. Corn, which is one of the most favored host plants, is grown nearly everywhere. While observations can be made on other hosts sufficiently distant from corn to preclude larval migration as their source, observations can not be taken at points sufficiently distant to preclude the possibility of infestation caused by moths flying from the corn.

Since corn is the most widely distributed host of the borer, the weeds most frequently associated with corn are likewise widely distributed as hosts. Of these, the more important, in the order named, are ragweed, pigweed (*Amaranthus retroflexus*), knotweed, and barnyard grass. Ragweed has by far the widest distribution (Table 3), doubtless because it is a favorite host and because it is the weed most often found in fields of corn. Cocklebur, although a common weed of cultivated fields in certain parts of the West, is practically never found in the infested part of New England except in waste places or on the sandy soil along streams or by the ocean.

Although severe injury is found most frequently in host plants associated with badly infested corn, it should not be taken for granted that this is always the case. Beet, celery, dahlia, Japanese millet, cocklebur, knotweed, ragweed, and to a lesser extent many other plants, have been found attacked at sufficient distances from corn to preclude migration of larvae as the reason for their infestation. Also the large weed areas so frequently alluded to are not associated with corn and are frequently several miles distant from any considerable-sized planting of corn.[8] The small garden patches of corn anywhere near these areas can not be responsible for the thousands of larvae found in the weeds, but rather the gardens are subject to injury because they are located near such infestation centers. That these infestations, nevertheless, had their origin in

8 That large populations of insects [illegible]

refuse corn or other garden trash, or in moths originating from corn, is quite likely.

Not only are certain plants infested more or less independently of corn, but it is likely that some infestations in crops have occurred because of the absence of corn; that is, corn would doubtless have served as a trap crop. The worst infestations in beets, celery, and some other plants have not always been found when they were located near badly infested corn, but often in market gardens at considerable distances from plantings of corn.

Because of the difficulty of observing such infestations under conditions entirely isolated from corn, there is no way, under natural conditions,[18] of knowing whether or not the borer can live on certain host plants through a succession of its seasonal cycles. There is some evidence in the more or less isolated and heavily infested areas of cocklebur that this plant has supported the borer for several years without corn having served as an intermediate host. The large numbers of borers year after year in these locations can not be attributed to any outside source. For the same reason it is beyond a shadow of doubt that weed areas have served not only to increase greatly the insect population but also to carry the insect through a number of seasonal cycles; in fact, the areas of mixed weeds seem peculiarly adapted to the needs of the insect. In such areas the moths have an abundance of oviposition sites as well as ample protection during the day. The borers, by means of very short migrations, are able to find food in good condition throughout the whole season. Furthermore, there are always suitable places for hibernation and pupation, if not in the plant fed upon, at least in some plant near by; and, except where clean-up measures are applied, there is no time during the insect's seasonal cycle when the destruction of great numbers of the insect makes it necessary for a new population to be built up each year from a few individuals, as is the case when corn alone is the host.

Cocklebur growing in communities is usually found infested even when well outside the area of severe infestation. On the other hand, plants of this genus when occurring singly or in very limited numbers in their natural habitat along the beaches or streams, are often not attacked even though growing within the area of severe infestation. The reverse seems to be true of knotweed (Polygonum), though in reality it is not. The larger species growing in rather pure stands in their native habitat near marshes and in other rich, moist ground, though infested, are seldom so severely attacked as is cocklebur, whereas single, or a few scattered, plants are frequently found severely injured. The answer to this is, doubtless, that isolated cocklebur plants in their native habitat are often considerably removed from other host plants, whereas Polygonum plants occurring in small numbers have usually been examined when growing near corn or other crops. When occurring in areas of mixed weeds both are freely attacked, the cocklebur most frequently.

Hemp is one of the most favored host plants, as is evidenced by the extent to which individual plants are injured and the high frequency of infestation in a plant so thinly scattered. This plant, in the eastern Massachusetts environment, is not a weed of cultivated fields and does not occur in natural waste areas, but is entirely con-

[18] Cage experiments have been started with a number of plant species in order to learn how long the borer can maintain its existence on certain plants and what reaction the plants will have on the insect.

food to the dump areas, where it helps to make up that great variety of host plants which frequently constitute more important and permanent foci of infestation than any one species of plant growing in a pure stand.

In areas of marsh, grassland, pasture, or woodland, away from the large centers of infestation, plants are rarely found infested. This is doubtless because most of the host-plant species occurring in these places are of the less-preferred type, as vervain, pokeweed, the smaller grasses, the clovers, the asters, and goldenrod. In such areas there are seldom enough of the preferred hosts to support even a small population of borers.

Except in corn and the weeds growing near it, there is little infestation in the real farming communities. Although this better condition may be brought about by the more thorough clean-up methods customary on farms, it is doubtless also due to the intimate distribution of the preferred host plants.

The continuity of favorite host plants, however, is not absolutely essential to the spread of the borer. Isolated infestations indicate that barriers of city blocks or woodland are not effective in preventing infestation. Cocklebur has been found rather commonly infested on vacant lots in cities, apparently shut off from other likely host plants by miles of brick, walls, and pavements. It is not uncommon to find small patches of infested corn surrounded by acres of woodland and meadow. In these cases the apparent barriers are doubtless overmatched by the ability of the moths to fly several miles and to surmount such obstacles.

RELATIVE FREQUENCY WITH WHICH HOST PLANTS ARE INFESTED

The plants upon which the corn borer has been found are divided into three classes of comparative infestation: Frequent, uncommon, and rare. In determining the relative frequency of infestation in plants, the frequency of occurrence of the plant is considered as well as the intensity of infestation and the number of plants found infested. Some of the plants have been found only once or at most a very few times, or have been grown in very limited numbers in the experiment fields only. Because of lack of sufficient information concerning these plants as hosts, they have not been classified as to their relative frequency of infestation.

This triple division is undeniably superficial, and the range in any one of the divisions is rather large. For example, cocklebur and ragweed are both placed in the group of frequently infested plants, yet the former, when the abundance of the two plants is considered, is much more frequently infested. In view of the fact that all hosts can not be found growing under similar conditions and occurring in equal abundance, it seems impractical to the writer to attempt any finer division; it is doubtful, moreover, if anything would be gained by so doing.

DIRECT COMPARISON

There have been numerous opportunities to compare the infestation in several kinds of plants growing under similar conditions. Some rather detailed examinations have been made of species of the same genus, and of varieties of the same species. (Tables 2 and 3.) Some of the facts brought out by these and other comparisons that have

been made are the following: Corn is sometimes less severely infested than other host plants growing with or near it. *Rumex obtusifolius* is much preferred to *R. crispus* both for oviposition by the adult and as food by the larvae; there is no notable difference in the infestation in the several large annual species of Polygonum; sunflower (*Helianthus annuus*) is more frequently infested than Jerusalem artichoke (*H. tuberosus*); *Panicum dichotomiflorum* is more susceptible than *P. capillare*; potato is the most frequently infested of the solanaceous plants; of the genus Holcus, Johnson and Sudan grasses are much less severely infested than the grain and saccharine sorghums and broomcorn; sugar beets are rarely infested as compared with common beets. (See also p. 45.)

TABLE 6.—*Direct comparisons of infestation by the corn borer in weed hosts*[1]

Groups[2]	Plants examined	Plants infested	Stems containing borers	Total borers	Maximum borers in one stem	Remarks
First:	*Number*	*Per cent*	*Per cent*	*Number*	*Number*	
Polygonum hydropiper	20	95	85	100	------	[illegible]
Polygonum [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	------	
Polygonum lapathifolium	20	50	25	10	------	
Polygonum persicaria	10	40	10	1	1	
Second:						
Corn	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Xanthium	100	98	95	644	35	
Ambrosia elatior	[illegible]	(3)	[illegible]	[illegible]	[illegible]	
Chenopodium ambrosioides	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Bidens frondosa	50	78	48	40	5	
Arctium minus	25	75	16	8	3	
Artemisia biennis	50	50	30	54	6	
Amaranthus retroflexus	50	42	32	19	2	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Third:						
Bidens frondosa	25	72	48	21	5	[illegible]
Arctium minus	10	70	40	16	7	
Amaranthus retroflexus	20	45	30	7	2	
Oenothera	25	8	8	2	1	
Cichorium intybus	50	0	0	0	0	
Melilotus alba	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Fourth:						
Ambrosia elatior	25	(3)	64	27	6	[illegible]
Polygonum	25	84	64	19	2	
Erechtites hieracifolia	25	32	20	5	1	
Bidens frondosa	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible] vulgare	25	16	12	5	3	
Erigeron canadensis	30	10	10	4	[illegible]	
Fifth:						
Hemp	6	100	100	33	11	[illegible]
Xanthium	25	100	100	178	15	
Arctium minus	20	70	45	32	17	
Polygonum	25	82	44	62	27	
Ambrosia elatior	25	(3)	28	7	1	
Artemisia biennis	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Chenopodium ambrosioides	50	30	28	16	2	
Bidens frondosa	30	17	17	12	5	
Sixth:						
Corn	100	[illegible]	------	------	------	[illegible]
Amaranthus retroflexus	100	6	------	------	------	
Seventh:						
Rumex obtusifolius	50	98	------	------	------	[illegible]
Rumex crispus	50	12	------	------	------	

[1] These are a few samples of [illegible]

[2] Each group is a unit of comparison [illegible]

[3] The total number of infested plants of Ambrosia was not known in some cases because the infestation by Papaipema was rather common and might have been mistaken for that of *Pyrausta nubilalis*.

TABLE 6.—*Direct comparisons of infestation by the corn borer [illegible]*—Con.

Groups	Plants dissected	Plants infested	Plants containing borers	Total borers	Most borers in one plant	Remarks
Eighth:	*Number*	*Per cent*	*Per cent*	*Number*	*Number*	
Corn	50	90	58	74	17	Cultivated land grown up to weeds, at Worcester, Mass. Examined Nov. [illegible], 192[illegible]
[illegible]	50	34	28	28	6	
[illegible]	[illegible]	[illegible]	10	[illegible]	[illegible]	
[illegible]	[illegible]	8	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	4	4	[illegible]	[illegible]	
Ninth:						
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Cultivated land grown up to weeds, at Worcester, Mass. Examined Nov. 10, 192[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Tenth:						
Corn	30	23	....	....	....	At Woburn, Mass. Examined Nov. 10, 19[illegible]
[illegible] elatior	40	17	....	....	2	
Eleventh:						
Corn	30	35	25	15	4	Cultivated land grown up to weeds [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	50	16	6	3	1	
Amaranthus retroflexus	50	12	12	6	1	
Twelfth:						
Xanthium	25	100	88	122	15	Dump area, at Woburn, Mass. Examined Dec. [illegible], 192[illegible]
Arctium minus	50	74	38	69	7	
Iva xanthiifolia	50	64	34	35	4	
Urtica procera (nettle)	50	4	2	1	1	

[1] The total number of infested plants of [illegible]

MAXIMUM INFESTATIONS

Although it is next to impossible to make a graded list showing just what relative position as host each of the two hundred and odd plants occupies, based either on such comparisons as have been made or on a general average as is done with a few of the more important crop plants, yet it is possible, as in Table 7, to give the maximum number of borers found in some of them as determined by a great many dissections. These numbers are an indication of the severity of infestation which existed in the several plants, but should not be given undue consideration because maximums, being extremes, might easily be misleading. Some of these plants, moreover, probably show a concentration of immigrant larvae.

TABLE 7.—*Maximum number of borers found in a single plant of some of the more important hosts of the European corn borer*

Plant	Number of borers	Plant	Number of borers
[illegible]	200	Calendula	11
Barnyard grass	150	Pepper	11
[illegible]	117	Celery	10
Burdock	101	Broomcorn	9
[illegible]	98	Horseweed	9
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	49	Rhubarb	8
[illegible]	40	Wormseed	7
[illegible]	37	Potato	7
Beggar ticks	34	Biennial wormwood	6
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	22	Kafir	5
[illegible]	19	Bean	4
[illegible]	15	Goldenrod	3
[illegible]	15	Wild lettuce	3
[illegible][1]	[illegible]	[illegible]	[illegible]

[1] This was a large plant containing a great many culms.

DEVELOPMENT, ABUNDANCE, AND RELATIVE SIZE OF HOST PLANTS AND THEIR NUMBER PER UNIT OF AREA

The season of plants, their changing abundance, and their condition of development must also be considered when attempting to compute them as hosts. Late celery is much more frequently infested than early celery. Beans are very lightly infested early in the year when they are usually planted for the market; those planted later are much more frequently and severely attacked. These later and more severe infestations should be considered, when classifying this plant, even though they do not represent so large an acreage. Dock, early in the season, appears to be by far the most favored host, but later in the season it is of little importance. (See p. 42.)

The size of the plant should be taken into consideration when injury and number of larvae per plant are computed. For instance, one or two larvae with a few inches of excavated stem in a hop vine or beet plant constitute, relatively speaking, just as severe an infestation as a few feet of tunnel and a greater number of borers in a larger plant. What is more, the volume of injury and population of borers are made up for, or even exceeded, in the smaller plants by greater numbers per unit of area. For example, in the surveys of market gardens (Table 1) beets with an average of 29.4 per cent of the plants infested showed an estimated average larval population per acre of 22,000, while sweet corn with an 18 per cent infestation contained only 4,100 larvae per acre. In this case the average number of larvae per infested plant was for beets 3.4 and for corn 1.4. If only severely infested fields were considered, however, the corn would probably have the greater number of borers per unit area because of its capacity for carrying a much greater number of borers per plant.

FLUCTUATION IN THE NUMBER OF INSECTS AND CHANGES IN THEIR HABITS

While fluctuation in the number of insects from generation to generation and from year to year probably does not greatly affect the relative frequency of infestation in the more favored and commonly occurring host plants, it doubtless has the effect of eliminating many of the less favored or rarely occurring ones in seasons when the borers are scarce. This is especially true of those attacked by migrating larvae. Moreover, in those kinds of plants infested during years of reduced infestation the range of relative infestation may be greater than in the same plants in years or places of heavy infestation. For example, in the season of 1920 all of the grain sorghums at the Sanger experiment field were 100 per cent infested, but in a more lightly infested location (Woburn experiment field) in 1921 there was a range of infestation, which allowed a better opportunity for comparing them. (See Table 2.)

The corn borer from time to time seems eccentric in its food-plant reactions. Tansy and yarrow were found only occasionally infested when the borer was most plentiful, but in 1925, when the borers were not extremely numerous, both of these plants were found badly infested. They were not found near severely infested corn or associated with other badly infested weeds. These may have been unusual cases, or it may have been a new development of the insect's feeding habits. Although many borers have been found in burdock, and it was once considered one of the more favored host plants, it has been difficult for several years to find this plant attacked except

in severely infested spots. This, however, may be accounted for by the general reduction in intensity of infestation since 1933.

Considering, then, all these points—direct comparisons of plants when possible, the extreme injury and maximum borer populations which each has been found to sustain, the changing abundance and condition of plants, the relative size of the hosts, the fluctuations in infestation, new developments and possibly changing food habits, and a general suppression of relative infestation being given due weight always being given to the relative abundance of the plants) formed over a number of years' work—a list, indicating roughly the comparative infestation in the host plants of the European corn borer, is offered in Table 8. This is done with some hesitation since it is exceedingly difficult to make comparisons when the plants are found under such varying conditions.

STATUS OF THE PLANTS AS HOSTS OF THE BORER

In the classification of the plants according to their status as hosts of the insect, they have been divided into the following groups: (1) Plants which serve as both food and hibernating material; (2) plants probably serving for food and as shelter during the feeding periods and first-generation pupation only; (3) plants subject to migrating larvae; and (4) plants unclassified because of insufficient data. In addition to this classification, plants upon which all stages have been found and plants probably serving only as hibernating material are indicated.

To be a complete host of the borer it is not only necessary that a plant serve both as food and hibernating material for the large larvae, but also that it be suitable for oviposition and provide proper food and conditions for the successful subsistence of all instars of the larva. The plant may, however, be only a partial host and yet be important from the standpoint of economic loss, quarantine regulations, or clean-up measures. That a plant be a complete host is not necessary in order that the insect may round out its seasonal cycle, as the larvae will freely migrate to the plants most suited to their purposes. The work of determining the complete hosts, therefore, is not necessary and has not been stressed. It is known, however, that a few of the commoner hosts can be classed as complete, the insect having been observed in every life stage and in every larval instar on the plant.

In the group of plants which serve both as food and as hibernating quarters, indicated in the last column in Table 8 by H, are included all plants which it is reasonably certain have been used as food and in which the larvae have overwintered.

The grasses do not make the best of hibernating material, and probably some of the smaller ones are seldom or never used by the insect for this purpose. A number of the annual flowering plants and weeds are unsuitable, or almost so, for hibernation, chief among these are mignonette, balsam, Japanese hop, portulaca, and galinsoga. The vegetables which offer inadequate winter protection are celery, beet, rhubarb, Swiss chard, and mangel. The plants which are known to have been used for food, but not for protection to the larvae throughout the winter, are indicated by F.

Many plants are known to have been infested only by migrating larvae. In some cases these larvae apparently relish the new food, whereas in others they merely excavate sufficient material to provide protection for themselves. These plants have been classified as attacked by migrating larvae and are indicated by M. If they serve as hibernating material also this has been indicated.

As it has been impossible to more than guess at the host-plant status of a great many rarely infested plants, they have been listed under "Status unknown," indicated by U.

TABLE 8.—*Record of the European corn borer on host plants in New England* [1]

Botanical and common names of host plants arranged according to the systematic sequence	First-generation stages found on plants				Second-generation stages found on plants					[illegible]			[illegible]	[illegible]
	Eggs	Larvae	Pupae	Adults	Eggs	Larvae	Larvae (II)	Pupae	Adults	Larvae	[illegible]	[illegible]	[illegible]	[illegible]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Equisetaceae (Horsetail family): Equisetum sp. (horsetail)						R					R		R	O
Typhaceae (Cat-tail family): Typha latifolia L. (common cat-tail)						R					R		(U)	O
Poaceae (Grass family):														
Euchlaena mexicana Schrad. (teosinte)		R			R	R				R	R		E	O
Zea mays L. (dent, flint, pop, and sweet corn)	F	F	F	F	F	F	F	F	F	F	F	F	I	H*
Holcus halepensis L. (Johnson grass)					R	R				R	R		R	[illegible]
Holcus sorghum L.:														
Broomcorn	R	R	R	R	O	O	R	R	C	O	O		E	R*
Feterita	R				O	O	R	R	C	O	O		E	R*
Hegari	R				O	O	R	R	R	O	O	R	E	R*
Kafir					O	O	R	R	R	O	O		E	R*
Milo	R				O	O	R	R	C	O	O	R	E	R*
Sorgo	R				O	O	R	R	C	O	O	R	E	R*
Sudan grass	R				O	O				R	O		E	R*
Panicum capillare L. (old-witch grass)		R	C		O	O					O		II	F
Panicum dichotomiflorum Michx. (spreading witch grass)						O	R	R	R		O		I	R
Panicum miliaceum L. (broomcorn millet)	R	O	R	R	R	R					O		E	R*
Syntherisma sanguinalis (L.) Dulac (crab grass)						O	R	R	F		O		II	R
Echinochloa crusgalli (L.) Beauv. (barnyard grass)	R	R	R		R	F	F	F	F	F	F*		I	H*
Echinochloa frumentacea Link (Japanese millet)	R	R	R	R	R	O	R	R	R		O		I	H*
Pennisetum glaucum (L.) R. Br. (pearl millet)		R	R	R							R		E	F
Chaetochloa lutescens (Weigel) Stuntz (yellow foxtail)						R	R	F	F		R	R	III	H
Chaetochloa viridis (L.) Scribn. (green foxtail)		R									R		III	F
Chaetochloa italica (L.) Scribn. (Hungarian millet)	R	R	R								R		E	F*
Chaetochloa italica germanica (Mill.) [illegible] (German millet)		R									R		E	F
Phleum pratense L. (timothy)	C	R	C	C		R					R		E	F
Avena sativa L. (oat)	R	R	R	C		O				R	R	R	III	F
Triticum aestivum L. (wheat)	C	R	R	R							O		II	F*
Hordeum vulgare L. (barley)	O	R	R			R					R		E	F
Liliaceae (Lily family): Asparagus officinalis L. (asparagus)											R		E	F
Iridaceae (Iris family): Gladiolus hybrida (gladiolus)						R	R				R		III	M[2]
Cannaceae (Canna family): Canna hybrida (canna)		O	R	C	R	O	R	R	R	O	O	R	II	H*
Moraceae (Mulberry family):		F			R	O				R	O	R	II	F
Cannabis sativa L. (hemp)	C	R	R	R	C	F	F	F	F		F	O	I	H
Humulus japonicus Sieb. and Zucc. (Japanese hop)														
Humulus lupulus L. (common hop)		R	R	R		F O	R	R			F O		I I	H F

See footnotes at end of table.

TABLE 8.—*Record of the European corn borer on host plants in New England*—Continued

Botanical and common names of host plants arranged according to the Gleason key sequence	First generation—Sequence of collection periods				Second generation—Sequence of collection periods		Number of larvas found on—			Number of larvae found in—			Total number of larvae found	Total number of pupae found
	Early	Late June	Early July	Late July	Early Aug.	Late Aug.	Leaves	Stems	Adults	Leaves	Stems	Flowers, fruits		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Polygonaceae (Buckwheat family):														
Polygonum virginianum L. (Jumpseed; Virginia knotweed)			A										2	P
Polygonaceae (Buckwheat family):														
Rumex crispus L. (Curled dock)														
Rumex obtusifolius L. (Bitter dock)														
Rumex acetosella L. (Sheep sorrel)														
Polygonum aviculare L. (Common knotweed)							R						1	P
Polygonum convolvulus L. (Black bindweed)														
Polygonum cuspidatum Sieb. & Zucc. (Japanese knotweed)														
Polygonum sagittatum L. (Arrow-leaved tearthumb)														
Polygonum scandens L. (Climbing false buckwheat)														
Polygonum cilinode Michx. (Fringed bindweed)														
Polygonum sp.														
Polygonum tenue Michx. (Slender knotweed)														
Polygonum persicaria L. (Lady's-thumb)														
Polygonum hydropiper L. (Marshpepper knotweed)														
Polygonum lapathifolium L. (Curlytop knotweed)														
Polygonum sp.														
Fagopyrum esculentum Moench (Buckwheat)														
Rheum rhaponticum L. (Rhubarb)														
Chenopodiaceae (Goosefoot family):														
Chenopodium album L. (Lamb's-quarters)														
Chenopodium hybridum L. (Maple-leaved goosefoot)														
Chenopodium album L. (Lamb's-quarters)														
Beta vulgaris subsp. Cicla (L.) Ulrich (Swiss chard)														
Beta vulgaris subsp. Cicla (L.) Ulrich (Swiss chard)														
Beta vulgaris subsp. Cicla (L.) Ulrich (Swiss chard)														
Beta vulgaris subsp. Cicla (L.) Ulrich (Swiss chard)														
Kochia scoparia (L.) Schrad. (Summer cypress)														
Atriplex patula hastata (L.) Gray (Halberd-leaved orache)														
Spinacia oleracea L. (Spinach)														
Amaranthaceae (Amaranth family):														
Amaranthus retroflexus L. (Redroot; pigweed)														
Amaranthus hypochondriacus L. (Prince-of-Wales-feather)														
Amaranthus tuberculatus (Moq.) Sauer (Roughfruit amaranth)														
Celosia argentea L. (Cockscomb; plumed celosia)														
Celosia cristata L. (Cockscomb; fiddle celosia)														
Phytolaccaceae (Pokeweed family): Phytolacca decandra L. (Pokeweed)														
Caryophyllaceae (Pink family): Silene noctiflora L. (Night-flowering catchfly)														
Portulacaceae (Purslane family):														
Portulaca oleracea L. (Common purslane)														
Ranunculaceae (Buttercup family):														
Aquilegia canadensis L. (Eastern columbine)														
Delphinium ajacis L. (Rocket larkspur)														
Delphinium consolida L. (Forking larkspur)														
Ranunculus acris L. (Tall buttercup)														
Ranunculus repens L. (Creeping buttercup)														
Ranunculus bulbosus L. (Bulbous buttercup)														
Ranunculus sceleratus L. (Cursed crowfoot)														
Anemone canadensis L. (Canada anemone)														
Anemone virginiana L. (Tall thimbleweed)														
Anemone cylindrica A. Gray (Long-fruited anemone)														
Anemone quinquefolia L. (Wood anemone)														
Anemone sylvestris L. (Snowdrop anemone)														
Anemone virginiana L. (Tall thimbleweed)														
Anemone cylindrica A. Gray (Long-fruited anemone)														
Anemone quinquefolia L. (Wood anemone)														
Anemone sylvestris L. (Snowdrop anemone)														
Clematis virginiana L. (Virgin's-bower)														
Clematis vitalba L. (Traveler's-joy)														
Thalictrum dioicum L. (Early meadow-rue)														
Thalictrum polygamum Muhl. (Tall meadow-rue)														
Thalictrum revolutum DC. (Waxyleaf meadow-rue)														
Berberidaceae (Barberry family):														
Podophyllum peltatum L. (Mayapple)														
Berberis vulgaris L. (Common barberry)														
Berberis thunbergii DC. (Japanese barberry)														
Papaveraceae (Poppy family):														
Sanguinaria canadensis L. (Bloodroot)														
Papaver rhoeas L. (Shirley poppy)														
Papaver somniferum L. (Opium poppy)														
Fumariaceae (Fumitory family):														
Dicentra cucullaria (L.) Bernh. (Dutchman's-breeches)														
Dicentra canadensis (Goldie) Walp. (Squirrel corn)														
Dicentra eximia (Ker) Torr. (Fringed bleeding-heart)														
Dicentra spectabilis (L.) Lem. (Bleeding-heart)														
Fumaria officinalis L. (Common fumitory)														
Cruciferae (Mustard family):														
Barbarea vulgaris R. Br. (Yellow rocket)														
Barbarea verna (Mill.) Asch. (Early winter cress)														
Nasturtium officinale R. Br. (Watercress)														
Arabis hirsuta (L.) Scop. (Hairy rockcress)														
Arabis glabra (L.) Bernh. (Tower rockcress)														
Arabis laevigata (Muhl.) Poir. (Smooth rockcress)														
Arabis canadensis L. (Sicklepod)														
Arabis lyrata L. (Lyreleaf rockcress)														
Arabis sp.														
Cardamine pratensis L. (Cuckoo flower)														
Cardamine bulbosa (Schreb.) BSP. (Spring cress)														
Cardamine hirsuta L. (Hairy bittercress)														
Cardamine rotundifolia Michx. (Round-leaved bittercress)														
Cardamine sp.														
Dentaria diphylla Michx. (Two-leaved toothwort)														
Dentaria laciniata Muhl. (Cut-leaved toothwort)														
Dentaria maxima Nutt. (Large toothwort)														
Dentaria sp.														
Erysimum cheiranthoides L. (Wormseed mustard)														
Erysimum parviflorum Nutt. (Small-flowered wallflower)														
Erysimum sp.														
Lepidium virginicum L. (Virginia pepperweed)														
Lepidium campestre (L.) R. Br. (Field pepperweed)														
Lepidium ruderale L. (Narrow-leaved pepperweed)														
Lepidium sp.														
Capsella bursa-pastoris (L.) Medic. (Shepherd's-purse)														
Brassica nigra (L.) Koch (Black mustard)														
Brassica rapa L. (Field mustard)														
Brassica oleracea L. (Cabbage)														
Brassica napus L. (Rape)														
Brassica sp.														
Raphanus raphanistrum L. (Wild radish)														
Raphanus sativus L. (Radish)														
Raphanus sp.														
Sinapis arvensis L. (Charlock)														
Sinapis alba L. (White mustard)														
Sinapis sp.														
Thlaspi arvense L. (Field pennycress)														
Thlaspi alliaceum L. (Garlic pennycress)														
Thlaspi sp.														
Hesperis matronalis L. (Dame's-rocket)														
Hesperis sp.														
Alliaria officinalis Andrz. (Garlic mustard)														
Cruciferae (Mustard family):														
Cruciferae sp.														

See footnote at end of table.

TABLE 8.—*Record of the European corn borer on host plants in New England*—Continued

Botanical and common names of host plants [illegible]	[illegible] 2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
[illegible] family):														
[illegible]						[illegible]	[illegible]	[illegible]			[illegible]		III	M
[illegible] family):						[illegible]					[illegible]		III	M
[illegible]						[illegible]					[illegible]		[illegible]	U
[illegible]						[illegible]					[illegible]		III	M
[illegible]		[illegible]				[illegible]					[illegible]		III	U
[illegible]						[illegible]					[illegible]		III	U
[illegible]						[illegible]					[illegible]		III	U
[illegible]					[illegible]	[illegible]				[illegible]			III	M
[illegible]	[illegible]					[illegible]				[illegible]			III	U
[illegible]						[illegible]	[illegible]	[illegible]			[illegible]		III	U
[illegible]						[illegible]				[illegible]			[illegible]	M
[illegible]		[illegible]	[illegible]								[illegible]		III	U
[illegible]		[illegible]									[illegible]		[illegible]	U
[illegible]	[illegible]												[illegible]	U
[illegible] (Mignonette family). Reseda [illegible]a L. (mignonette)						[illegible]				R			[illegible]	U
Ros[illegible] (Rose family):		[illegible]			[illegible]					R		[illegible]	III	[illegible]
[illegible]						[illegible]						[illegible]	[illegible]	M
[illegible]						[illegible]						[illegible]	[illegible]	M
[illegible]		[illegible]	[illegible]	[illegible]						R			[illegible]	[illegible]
[illegible]						[illegible]				R			III	M
[illegible]						[illegible]	[illegible]			R			[illegible]	[illegible]
[illegible]						[illegible]				R			III	[illegible]
Fabaceae (Pea family):						[illegible]				R			III	[illegible]
[illegible]						[illegible]				R			III	[illegible]
[illegible]						[illegible]				R			III	[illegible]
[illegible]		[illegible]	[illegible]							R			III	[illegible]
Phaseolus vulgaris L. [illegible]	[illegible]	[illegible]	[illegible]			[illegible]				R			R	[illegible]
Phaseolus coccineus L. [illegible]										O	[illegible]		II	[illegible]
[illegible]		[illegible]				[illegible]				R	[illegible]		R	[illegible]
[illegible]		[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	R	[illegible]		R	[illegible]
[illegible]		[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	R	[illegible]		E	[illegible]
[illegible]		[illegible]			[illegible]	[illegible]	[illegible]	[illegible]		R	[illegible]		E	[illegible]
[illegible]										R			E	[illegible]
[illegible]		[illegible]				[illegible]	[illegible]	[illegible]	[illegible]	O			II	[illegible]
[illegible]						[illegible]			[illegible]				R	U
[illegible]ceae (Balsam family):						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		III	M
Impatiens biflora Walt. (jewelweed)					[illegible]	[illegible]	[illegible]				[illegible]		III	U
Impatiens balsamina L. (balsam)						[illegible]					[illegible]		III	F
Vitaceae (Vine family). Vitis labrusca L. (fox grape)						[illegible]					[illegible]	[illegible]	III	M
M[illegible] (Mallow family): [illegible]					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	H

See footnotes at end of table.

TABLE 8.—*Record of the European corn borer on host plants in New England*—Continued

Families and common names of host plants (arranged according to botanical sequence)	First generation: Eggs	Larvae	Pupae	Adults	Second generation: Eggs	Larvae	Larvae II	Pupae	Adults	Stage in which found			Locality	Authority
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Malvaceae (Mallow family): Abutilon theophrasti (velvet leaf)		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]		[illegible]	[illegible]
Althaea rosea Cav. (hollyhock)						[illegible]					[illegible]		[illegible]	[illegible]
Malva sylvestris L. (high mallow)						[illegible]					[illegible]		[illegible]	[illegible]
Hibiscus moscheutos L. (mallow)					[illegible]	[illegible]					[illegible]		[illegible]	[illegible]
Hibiscus syriacus L. (rose of sharon)						[illegible]					[illegible]		[illegible]	[illegible]
Gossypium herbaceum L. (cotton)		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	R				[illegible]	R	[illegible]	[illegible]
Violaceae (Violet family): Viola tricolor L. (pansy)						[illegible]					[illegible]	R	[illegible]	M
Lythraceae (Loosestrife family): Lythrum salicaria L. (purple loosestrife)		[illegible]				[illegible]					[illegible]		[illegible]	[illegible]
Lythrum salicaria roseum (Lam.) (rose loosestrife)						[illegible]	R				[illegible]		[illegible]	[illegible]
Onagraceae (Evening-primrose family): Oenothera biennis L. (evening primrose)						[illegible]	R	[illegible]			[illegible]		[illegible]	[illegible]
Apiaceae (Parsley family): Conium maculatum L. (poison hemlock)						[illegible]				[illegible]	[illegible]		[illegible]	[illegible]
Apium graveolens (L.) Endlicher (celery)		R	R		[illegible]	[illegible]					[illegible]		[illegible]	[illegible]
Pastinaca sativa L. (parsnip)		[illegible]	[illegible]	[illegible]										
Asclepiadaceae (Milkweed family): Asclepias syriaca (common milkweed)						[illegible]					[illegible]		[illegible]	[illegible]
Asclepias tuberosa L. (butterfly weed)						[illegible]					[illegible]		[illegible]	[illegible]
Boraginaceae (Borage family): [illegible] (comfrey)						[illegible]					[illegible]	R	[illegible]	[illegible]
Verbenaceae (Vervain family): Verbena hastata L. (blue vervain)						[illegible]					[illegible]		[illegible]	[illegible]
Menthaceae (Mint family):						[illegible]					[illegible]		[illegible]	[illegible]
Nepeta cataria L. (catnip)														
Physostegia virginiana L. (false dragonhead)						[illegible]					[illegible]		[illegible]	[illegible]
Leonurus cardiaca L. (motherwort)						[illegible]					[illegible]	R	[illegible]	[illegible]
Salvia splendens Ker (scarlet sage)	[illegible]					[illegible]					[illegible]		[illegible]	[illegible]
Monarda didyma L. (oswego bee balm)						[illegible]					[illegible]	R	[illegible]	[illegible]
Mentha spicata L. (spearmint)						[illegible]					[illegible]		[illegible]	[illegible]
Mentha arvensis canadensis (L.) Briquet (wild mint)						[illegible]					[illegible]		[illegible]	[illegible]
Coleus blumei Benth (coleus)														
Solanaceae (Nightshade family): Solanum nigrum L. (black nightshade)						[illegible]					[illegible]		[illegible]	[illegible]
Solanum tuberosum L. (potato)	[illegible]	[illegible]	[illegible]	[illegible]										
Solanum carolinense L. (horse nettle)						[illegible]						R	[illegible]	[illegible]
Solanum dulcamara L. (bittersweet)						[illegible]				[illegible]		R	[illegible]	[illegible]
Lycopersicum esculentum Mill. (tomato)		[illegible]			[illegible]	[illegible]	R R	[illegible]	[illegible]		[illegible]	R C R	[illegible]	[illegible]
Capsicum annuum L. (red pepper)						[illegible]							[illegible]	[illegible]
Physalis pruinosa L. (ground cherry)														
Nicandra physalodes (L.) Pers. (apple of Peru)					[illegible]	[illegible]					[illegible]	R	[illegible]	[illegible]
Datura stramonium L. (Jimson weed)					[illegible]	[illegible]	R	[illegible]			[illegible]	R	[illegible]	[illegible]
Datura tatula L. (purple Jimson weed)	[illegible]	[illegible]			[illegible]	[illegible]	F	[illegible]			[illegible]	R	[illegible]	[illegible]
Datura sp. (Jimson weed)														
Nicotiana tabacum L. (tobacco)														
Plantaginaceae (Plantain family): Plantago major L. (plantain)	[illegible]												[illegible]	[illegible]
Caprifoliaceae (Honeysuckle family): Sambucus canadensis L. (elder)						[illegible]	R	[illegible]	[illegible]		[illegible]		[illegible]	[illegible]
Dipsacaceae (Teasel family): Dipsacus sylvestris (teasel)						[illegible]					[illegible]		[illegible]	[illegible]
Cucurbitaceae (Gourd family):						[illegible]						[illegible]	[illegible]	[illegible]
Cucumis sativus L. (cucumber)						[illegible]				[illegible]		[illegible]	[illegible]	[illegible]
Cucurbita maxima (squash)														
Cucurbita pepo condensa Bailey (bush pumpkin)						[illegible]				[illegible]		[illegible]	[illegible]	[illegible]

* See footnotes at end of table.

TABLE 8.—*Record of the European corn borer on host plants in New England*—Continued

Botanical and common names of host plants arranged according to the systematic sequence													
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Asteraceae (Compositae family):														
Ageratina altissima (L.) King & H. E. Robins. (white snakeroot)														
Ambrosia artemisiifolia L. (common ragweed)														
Ambrosia trifida L. (giant ragweed)														
Antennaria neglecta Greene (field pussytoes)														
Arctium minus (Hill) Bernh. (common burdock)														
Artemisia vulgaris L. (mugwort)														
Bidens frondosa L. (beggarticks)														
Centaurea cyanus L. (bachelor's-button)														
Cichorium intybus L. (chicory)														
Cirsium arvense (L.) Scop. (Canada thistle)														
Cirsium vulgare (Savi) Ten. (bull thistle)														
Conyza canadensis (L.) Cronq. (horseweed)														
Eupatorium perfoliatum L. (boneset)														
Eupatorium rugosum Houtt. (white snakeroot)														
Helianthus annuus L. (common sunflower)														
Helianthus tuberosus L. (Jerusalem artichoke)														
Hieracium aurantiacum L. (orange hawkweed)														
Hieracium pilosella L. (mouse-ear hawkweed)														
Lactuca canadensis L. (wild lettuce)														
Lactuca scariola L. (prickly lettuce)														
Leucanthemum vulgare Lam. (oxeye daisy)														
Matricaria matricarioides (Less.) Porter (pineapple weed)														
Prenanthes alba L. (white lettuce)														
Rudbeckia hirta L. (black-eyed Susan)														
Senecio jacobaea L. (tansy ragwort)														
Senecio vulgaris L. (common groundsel)														
Solidago canadensis L. (Canada goldenrod)														
Solidago gigantea Ait. (late goldenrod)														
Solidago rugosa Mill. (rough goldenrod)														
Solidago spp.														
Sonchus arvensis L. (perennial sowthistle)														
Sonchus asper (L.) Hill (prickly sowthistle)														
Sonchus oleraceus L. (common sowthistle)														
Taraxacum officinale Weber (common dandelion)														
Tragopogon pratensis L. (goatsbeard)														
Betulaceae (Birch family):														
Alnus incana (L.) Moench (speckled alder)														
Alnus rugosa (Du Roi) Spreng. (speckled alder)														
Betula alleghaniensis Britton (yellow birch)														
Betula lenta L. (sweet birch)														
Betula papyrifera Marsh. (paper birch)														
Betula pendula Roth (European white birch)														
Betula populifolia Marsh. (gray birch)														
Betula spp.														
Corylus americana Walt. (American hazelnut)														
Corylus cornuta Marsh. (beaked hazelnut)														
Ostrya virginiana (Mill.) K. Koch (hophornbeam)														
Boraginaceae (Borage family):														
Cynoglossum officinale L. (hound's-tongue)														
Echium vulgare L. (blueweed)														
Lappula echinata Gilib. (European stickseed)														
Myosotis arvensis (L.) Hill (field forget-me-not)														
Myosotis laxa Lehm. (small forget-me-not)														
Myosotis scorpioides L. (true forget-me-not)														
Brassicaceae (Mustard family):														
Arabis glabra (L.) Bernh. (tower mustard)														
Arabis hirsuta (L.) Scop. (hairy rockcress)														
Barbarea vulgaris R. Br. (yellow rocket)														
Brassica kaber (DC.) L. C. Wheeler (wild mustard)														
Brassica nigra (L.) Koch (black mustard)														
Brassica rapa L. (field mustard)														
Capsella bursa-pastoris (L.) Medik. (shepherd's-purse)														
Cardamine hirsuta L. (hairy bittercress)														
Cardamine pensylvanica Muhl. (Pennsylvania bittercress)														
Cardamine rotundifolia Michx. (round-leaved bittercress)														
Descurainia pinnata (Walt.) Britton (tansy mustard)														
Descurainia sophia (L.) Webb (flixweed)														
Erysimum cheiranthoides L. (wormseed mustard)														
Lepidium campestre (L.) R. Br. (field pepperweed)														
Lepidium virginicum L. (Virginia pepperweed)														
Nasturtium officinale R. Br. (watercress)														
Raphanus raphanistrum L. (wild radish)														
Rorippa islandica (Oeder) Borbás (northern marsh yellowcress)														
Rorippa palustris (L.) Besser (yellow fieldcress)														
Sisymbrium officinale (L.) Scop. (hedge mustard)														
Thlaspi arvense L. (field pennycress)														
Campanulaceae (Bellflower family):														
Campanula aparinoides Pursh (marsh bellflower)														
Campanula rapunculoides L. (creeping bellflower)														
Campanula rotundifolia L. (harebell)														
Caprifoliaceae (Honeysuckle family):														
Lonicera japonica Thunb. (Japanese honeysuckle)														
Lonicera morrowii A. Gray (Morrow honeysuckle)														
Lonicera tatarica L. (Tatarian honeysuckle)														
Lonicera xylosteum L. (European fly honeysuckle)														
Sambucus canadensis L. (common elder)														
Sambucus racemosa L. (red elderberry)														
Viburnum acerifolium L. (mapleleaf viburnum)														
Viburnum alnifolium Marsh. (hobblebush)														
Viburnum lantanoides Michx. (hobblebush)														
Viburnum opulus L. (European cranberrybush)														
Viburnum recognitum Fernald (northern arrowwood)														
Viburnum trilobum Marsh. (American cranberrybush)														
Caryophyllaceae (Pink family):														
Arenaria serpyllifolia L. (thyme sandwort)														
Cerastium arvense L. (field chickweed)														
Cerastium fontanum Baumg. (mouse-ear chickweed)														
Dianthus armeria L. (Deptford pink)														
Dianthus barbatus L. (sweet William)														
Dianthus deltoides L. (maiden pink)														
Gypsophila paniculata L. (baby's-breath)														
Lychnis alba Mill. (white campion)														
Lychnis coronaria (L.) Desr. (rose campion)														
Lychnis flos-cuculi L. (ragged robin)														
Lychnis viscaria L. (clammy campion)														
Moehringia lateriflora (L.) Fenzl (grove sandwort)														
Myosoton aquaticum (L.) Moench (water chickweed)														
Saponaria officinalis L. (bouncingbet)														
Silene antirrhina L. (sleepy catchfly)														
Silene cucubalus Wibel (bladder campion)														
Silene latifolia Poir. (white campion)														
Silene noctiflora L. (night-flowering catchfly)														
Silene vulgaris (Moench) Garcke (bladder campion)														
Stellaria graminea L. (grass stitchwort)														
Stellaria media (L.) Vill. (common chickweed)														
Chenopodiaceae (Goosefoot family):														
Atriplex patula L. (common orache)														
Chenopodium album L. (lambsquarters)														
Chenopodium ambrosioides L. (Mexican-tea)														
Chenopodium hybridum L. (maple-leaved goosefoot)														
Chenopodium rubrum L. (red goosefoot)														
Salsola kali L. (Russian thistle)														
Cucurbitaceae (Gourd family):														
Cucumis sativus L. (cucumber)														
Cucurbita pepo L. (pumpkin)														
Elaeagnaceae (Oleaster family):														
Elaeagnus angustifolia L. (Russian-olive)														
Elaeagnus umbellata Thunb. (autumn-olive)														
Ericaceae (Heath family):														
Gaultheria procumbens L. (wintergreen)														
Vaccinium angustifolium Ait. (lowbush blueberry)														
Vaccinium corymbosum L. (highbush blueberry)														
Euphorbiaceae (Spurge family):														
Acalypha rhomboidea Raf. (common threeseed mercury)														
Euphorbia cyparissias L. (cypress spurge)														
Euphorbia esula L. (leafy spurge)														
Euphorbia helioscopia L. (sun spurge)														
Euphorbia maculata L. (spotted spurge)														
Euphorbia peplus L. (petty spurge)														
Fabaceae (Pea family):														
Amphicarpaea bracteata (L.) Fernald (hog peanut)														
Cytisus scoparius (L.) Link (Scotch broom)														
Lathyrus latifolius L. (perennial peavine)														
Lathyrus palustris L. (marsh pea)														
Lathyrus pratensis L. (meadow pea)														
Lespedeza capitata Michx. (round-headed bushclover)														
Lespedeza hirta (L.) Hornem. (hairy bushclover)														
Lespedeza stipulacea Maxim. (Korean bushclover)														
Lespedeza virginica (L.) Britton (slender bushclover)														
Lotus corniculatus L. (birdsfoot trefoil)														
Medicago lupulina L. (black medick)														
Medicago sativa L. (alfalfa)														
Melilotus alba Medik. (white sweetclover)														
Melilotus officinalis (L.) Lam. (yellow sweetclover)														
Robinia pseudoacacia L. (black locust)														
Trifolium arvense L. (rabbit-foot clover)														
Trifolium aureum Pollich (yellow hop clover)														
Trifolium hybridum L. (alsike clover)														
Trifolium pratense L. (red clover)														
Trifolium repens L. (white clover)														
Vicia cracca L. (bird vetch)														
Vicia sativa L. (common vetch)														
Vicia villosa Roth (hairy vetch)														
Fagaceae (Beech family):														
Castanea dentata (Marsh.) Borkh. (American chestnut)														
Quercus alba L. (white oak)														
Quercus borealis Michx. f. (northern red oak)														
Quercus ilicifolia Wangenh. (bear oak)														
Quercus rubra L. (northern red oak)														
Quercus velutina Lam. (black oak)														
Gentianaceae (Gentian family):														
Centaurium pulchellum (Sw.) Druce (lesser centaury)														
Gentiana andrewsii Griseb. (bottle gentian)														
Gentiana crinita Froel. (fringed gentian)														
Geraniaceae (Geranium family):														
Geranium carolinianum L. (Carolina geranium)														
Geranium dissectum L. (cutleaf geranium)														
Geranium maculatum L. (wild geranium)														
Geranium pusillum L. (small geranium)														
Geranium robertianum L. (herb-Robert)														
Hypericaceae (St.-John's-wort family):														
Hypericum boreale (Britton) Bicknell (northern St.-John's-wort)														
Hypericum canadense L. (Canada St.-John's-wort)														
Hypericum ellipticum Hook. (pale St.-John's-wort)														
Hypericum majus (A. Gray) Britton (large St.-John's-wort)														
Hypericum perforatum L. (common St.-John's-wort)														
Hypericum pyramidatum Ait. (great St.-John's-wort)														
Hypericum virginicum L. (Virginia St.-John's-wort)														
Iridaceae (Iris family):														
Iris pseudacorus L. (yellow iris)														
Iris versicolor L. (blue flag)														
Juncaceae (Rush family):														
Juncus effusus L. (common rush)														
Juncus tenuis Willd. (path rush)														
Lamiaceae (Mint family):														
Ajuga reptans L. (bugle)														
Glechoma hederacea L. (ground-ivy)														
Lamium amplexicaule L. (henbit)														
Lamium purpureum L. (purple deadnettle)														
Leonurus cardiaca L. (common motherwort)														
Mentha arvensis L. (wild mint)														
Mentha piperita L. (peppermint)														
Mentha spicata L. (spearmint)														
Nepeta cataria L. (catnip)														
Prunella vulgaris L. (common self-heal)														
Scutellaria galericulata L. (marsh skullcap)														
Stachys palustris L. (marsh hedgenettle)														
Stachys sylvatica L. (hedgenettle)														
Teucrium canadense L. (American germander)														
Liliaceae (Lily family):														
Allium canadense L. (meadow garlic)														
Allium vineale L. (field garlic)														
Asparagus officinalis L. (asparagus)														
Convallaria majalis L. (lily-of-the-valley)														
Hemerocallis fulva (L.) L. (orange daylily)														
Lilium philadelphicum L. (wood lily)														
Lilium tigrinum Ker-Gawl. (tiger lily)														
Maianthemum canadense Desf. (Canada mayflower)														
Polygonum aviculare L. (prostrate knotweed)														
Polygonum convolvulus L. (wild buckwheat)														
Polygonum cuspidatum Sieb. & Zucc. (Japanese knotweed)														
Polygonum hydropiper L. (water pepper)														
Polygonum pensylvanicum L. (Pennsylvania smartweed)														
Polygonum persicaria L. (lady's-thumb)														
Rumex acetosella L. (sheep sorrel)														
Rumex crispus L. (curly dock)														
Rumex obtusifolius L. (bitter dock)														
Primulaceae (Primrose family):														
Anagallis arvensis L. (scarlet pimpernel)														
Lysimachia ciliata L. (fringed loosestrife)														
Lysimachia nummularia L. (moneywort)														
Lysimachia quadrifolia L. (whorled loosestrife)														
Lysimachia terrestris (L.) Britton (swamp candles)														
Ranunculaceae (Buttercup family):														
Actaea rubra (Ait.) Willd. (red baneberry)														
Anemone canadensis L. (Canada anemone)														
Anemone virginiana L. (tall thimbleweed)														
Aquilegia canadensis L. (wild columbine)														
Caltha palustris L. (marsh marigold)														
Clematis virginiana L. (virgin's-bower)														
Ranunculus abortivus L. (kidneyleaf buttercup)														
Ranunculus acris L. (tall buttercup)														
Ranunculus bulbosus L. (bulbous buttercup)														
Ranunculus ficaria L. (lesser celandine)														
Ranunculus hispidus Michx. (hispid buttercup)														
Ranunculus pensylvanicus L. f. (Pennsylvania buttercup)														
Ranunculus repens L. (creeping buttercup)														
Thalictrum dioicum L. (early meadowrue)														
Thalictrum pubescens Pursh (tall meadowrue)														
Rosaceae (Rose family):														
Agrimonia gryposepala Wallr. (common agrimony)														
Agrimonia parviflora Ait. (harvest-lice)														
Amelanchier arborea (Michx. f.) Fernald (downy serviceberry)														
Amelanchier canadensis (L.) Medik. (shadblow serviceberry)														
Amelanchier laevis Wiegand (Allegheny serviceberry)														
Crataegus spp.														
Fragaria virginiana Duchesne (wild strawberry)														
Geum canadense Jacq. (white avens)														
Geum rivale L. (purple avens)														
Geum vernum (Raf.) Torr. & A. Gray (spring avens)														
Malus pumila Mill. (apple)														
Potentilla argentea L. (silvery cinquefoil)														
Potentilla canadensis L. (dwarf cinquefoil)														
Potentilla norvegica L. (Norwegian cinquefoil)														
Potentilla recta L. (sulfur cinquefoil)														
Potentilla simplex Michx. (common cinquefoil)														
Prunus avium (L.) L. (sweet cherry)														
Prunus cerasus L. (sour cherry)														
Prunus pensylvanica L. f. (pin cherry)														
Prunus serotina Ehrh. (black cherry)														
Prunus virginiana L. (chokecherry)														
Pyrus communis L. (common pear)														
Rosa blanda Ait. (smooth rose)														
Rosa canina L. (dog rose)														
Rosa eglanteria L. (sweetbrier)														
Rosa multiflora Thunb. (multiflora rose)														
Rosa rugosa Thunb. (rugosa rose)														
Rosa virginiana Mill. (Virginia rose)														
Rubus allegheniensis Porter (Allegheny blackberry)														
Rubus flagellaris Willd. (northern dewberry)														
Rubus hispidus L. (swamp dewberry)														
Rubus idaeus L. (red raspberry)														
Rubus occidentalis L. (black raspberry)														
Rubus odoratus L. (purple flowering raspberry)														
Rubus pubescens Raf. (dwarf raspberry)														
Sanguisorba canadensis L. (Canada burnet)														
Sanguisorba officinalis L. (great burnet)														
Spiraea alba Du Roi (white meadowsweet)														
Spiraea latifolia (Ait.) Borkh. (broadleaf meadowsweet)														
Rubiaceae (Madder family):														
Galium aparine L. (stickywilly)														
Galium asprellum Michx. (rough bedstraw)														
Galium boreale L. (northern bedstraw)														
Galium mollugo L. (hedge bedstraw)														
Galium palustre L. (marsh bedstraw)														
Galium triflorum Michx. (fragrant bedstraw)														
Salicaceae (Willow family):														
Populus alba L. (white poplar)														
Populus balsamifera L. (balsam poplar)														
Populus deltoides Marsh. (eastern cottonwood)														
Populus grandidentata Michx. (bigtooth aspen)														
Populus tremula L. (European aspen)														
Salix alba L. (white willow)														
Salix babylonica L. (weeping willow)														
Salix bebbiana Sarg. (Bebb willow)														
Salix discolor Muhl. (pussy willow)														
Salix eriocephala Michx. (heartleaf willow)														
Salix fragilis L. (crack willow)														
Salix humilis Marsh. (prairie willow)														
Salix lucida Muhl. (shining willow)														
Salix nigra Marsh. (black willow)														
Salix pedicellaris Pursh (bog willow)														
Salix petiolaris J. E. Smith (meadow willow)														
Salix purpurea L. (purple willow)														
Salix rigida Muhl. (heartleaf willow)														
Salix sericea Marsh. (silky willow)														
Salix viminalis L. (basket willow)														
Scrophulariaceae (Figwort family):														
Linaria vulgaris Hill (butter-and-eggs)														
Mimulus ringens L. (Allegheny monkeyflower)														
Scrophularia lanceolata Pursh (lanceleaf figwort)														
Scrophularia marilandica L. (carpenter's-square)														
Verbascum blattaria L. (moth mullein)														
Verbascum thapsus L. (common mullein)														
Veronica arvensis L. (corn speedwell)														
Veronica officinalis L. (common speedwell)														
Veronica peregrina L. (purslane speedwell)														
Veronica serpyllifolia L. (thyme-leaved speedwell)														
Solanaceae (Nightshade family):														
Datura stramonium L. (jimsonweed)														
Hyoscyamus niger L. (black henbane)														
Lycopersicon esculentum Mill. (tomato)														
Nicotiana rustica L. (wild tobacco)														
Nicotiana tabacum L. (tobacco)														
Physalis heterophylla Nees (clammy groundcherry)														
Solanum carolinense L. (Carolina horsenettle)														
Solanum dulcamara L. (bittersweet nightshade)														
Solanum nigrum L. (black nightshade)														
Solanum tuberosum L. (potato)														
Tiliaceae (Linden family):														
Tilia americana L. (basswood)														
Tilia cordata Mill. (littleleaf linden)														
Tilia europaea L. (European linden)														
Tilia platyphyllos Scop. (bigleaf linden)														
Urticaceae (Nettle family):														
Boehmeria cylindrica (L.) Sw. (false nettle)														
Laportea canadensis (L.) Wedd. (wood nettle)														
Parietaria pensylvanica Muhl. (Pennsylvania pellitory)														
Pilea pumila (L.) A. Gray (Canada clearweed)														
Urtica dioica L. (stinging nettle)														
Verbenaceae (Verbena family):														
Verbena hastata L. (blue vervain)														
Verbena urticifolia L. (white vervain)														
Violaceae (Violet family):														
Viola arvensis Murray (European field pansy)														
Viola blanda Willd. (sweet white violet)														
Viola canadensis L. (Canada violet)														
Viola cucullata Ait. (marsh blue violet)														
Viola pedata L. (bird's-foot violet)														
Viola pubescens Ait. (downy yellow violet)														
Viola rostrata Pursh (long-spurred violet)														
Viola sagittata Ait. (arrowleaf violet)														
Viola sororia Willd. (common blue violet)														
Vitaceae (Grape family):														
Parthenocissus quinquefolia (L.) Planch. (Virginia creeper)														
Vitis labrusca L. (fox grape)														
Vitis riparia Michx. (riverbank grape)														

See footnotes at end of table.

TABLE 8.—*Record of the European corn borer on host plants in New England*—Continued

Botanical and common names of host plants arranged according to the systematic sequence	First generation stages found on plants				Second generation stages found on plants					Parts of plant attacked			Relative infestation	Status as hosts
	Eggs	Larvæ	Pupæ	Adults	Eggs	Larvæ	Larvæ II	Pupæ	Adults	Leaves	Stems	Flowers, fruits		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Asteraceæ (Composite family)—Contd.														
Artemisia biennis Willd. (biennial wormwood)						F	R	R	R		F		I	H
Artemisia annua L. (sweet wormwood)		R	R			R	C	C	C		O		R	H
Tussilago farfara L. (coltsfoot)		R								R			R	U
Erechtites hieracifolia (L.) Raf. (fireweed)						F	R				F		I	H
Senecio vulgaris L. (common groundsel)						R					R		III	U
Calendula officinalis L. (calendula)						O	R	R	R		O	R	II	H
Arctium lappa L. (great burdock)						R	R				R		R	U [3]
Arctium minus Bernh. (burdock)	R	O	R	R		O	O	O	O		O		II	H [3]
Cirsium lanceolatum (L.) Hill (bull thistle)						R					R		III	U
Cirsium arvense (L.) Scop. (Canada thistle)						R					R		III	U
Cirsium spp. [1]		R	R			O					O		III	U
Cynara cardunculus L. (cardoon)						R				R			R	U
Centaurea cyanus L. (cornflower)		R				R					R		III	U
Centaurea moschata L. (sweet sultan)		R									R		R	U
Centaurea nigra L. (knapweed)		R	R			R	R	R			R		III	H
Cichorium intybus L. (chicory)	R					R	R				R		III	U [3]
Cichorium endivia L. (endive)		R	R	R		R	R				R	R	R	H
Sonchus oleraceus L. (sow thistle)		R									R		III	U
Sonchus asper (L.) Hill (spiny sowthistle)						R					R		III	U
Lactuca scariola integrata Gren. & Godr. (prickly lettuce)	R	R				R	R	C	C		R		III	H [3]
Lactuca sativa L. (lettuce)	R												III	U

[1] This is the complete list of plants upon which or in which eggs, larvæ, or pupæ of the European corn borer have been found, in New England. Tabulated with this list are the generations and stages of insect development known to occur on each, the parts of the plant attacked, and classifications of the hosts as to their relative infestation and as to their status as hosts of the insect. A key to the symbols used in the table follows:

Under stages (columns 2 to 10, inclusive) F, O, and R are used to indicate the relative frequency of occurrence of the several insect stages on the plant; F, frequently; O, occasionally; R, rarely occurring. C is used to designate stages found only in cage-rearing experiments (columns 2 to 7, inclusive), or to designate subsequent stages found in plants which were brought in from the field containing full-grown larvæ (columns 8, 9, 10).

Under parts of plant attacked (columns 11 to 13, inclusive) F, O, and R are used with the same relative meaning as under stages, but refer to frequency and extent of injury. In column 11 all plants are recorded in which some part of the leaf, including the petiole, has been considerably injured; plants upon which only very slight leaf feeding by the newly hatched larvæ has occurred have not been included. In column 12 all plants infested in the stems (either the main stalk or the branches) are listed. In column 13 all plants which have been infested in the flower, flower petiole, or that part of the plant stem which is likely to be picked with the flower are listed; also all plants infested in the fruit, seeds, or seed pods. Usually a plant infested in the flower is also infested in the developing seeds.

Under relative infestation (column 14) I, II, and III are used to denote frequently, occasionally, and rarely infested, respectively; in assigning a plant to any one of these three classes its relative abundance as well as its frequency of infestation is considered. Also in this column plants grown only, or almost only, in the experiment fields are designated by E, and plants examined only very rarely by R; no attempt is made to classify these plants as to their relative frequency of infestation.

Under status as hosts (column 15) the plants have been classed as follows: H, apparently true hosts serving for food and winter protection; F, serving as food plants, but not known to have been used as hibernating material; M, apparently attacked by large migrating larvæ which did not depend upon this plant to reach their full growth; and U, unclassified because of insufficient evidence.

[2] Known to have served as hibernating quarters.

[3] Plants also infested in the taproot (cocklebur, beet, and mangel) or in that part of the main stalk below the ground surface (corn and barnyard grass).

[4] Egg, larval, and pupal stages have been found on this plant. Cage rearings, except those of borers brought in from the field as full-grown larvæ to complete life-cycle records in a few plants, are not here considered. See use of C under footnote 1.

[5] The records under the genus, with species name not given, are derived from data in which the species was not designated, and are included here in order to make the information on the genus as a whole more complete. These, therefore, do not represent additional species and are not included in the total number of host-plant species and horticultural varieties. They are not included in the statistics on stages and generations in Table 4 or in the text, except when they carry a record not covered by a determined species of the same genus.

CONCLUSION

As stated early in this bulletin, most of the new host plants of the European corn borer were found during the years 1919 to 1922, inclusive. Since 1923 there have been no new names added to the list. This is partly because work on the host plants, especially that carried on in the experiment fields, has not been emphasized for the last four years. A more fundamental reason, however, is that with the general reduction in infestation in New England from 1923 to 1927, inclusive, the variety of plants upon which borers are found has decreased.

It is possible that the insect may be changing its food habit and tending to become specific on corn. This may also be connected with the insect's apparent trend toward a single generation. Sufficient time could not be given to this problem to make a very careful determination of the proportion of single-generation borers in 1926 and 1927, but such figures as are at hand indicate that in each of these years it exceeded the proportion in 1923. The average of single-generation borers recorded for previous years was as follows: In 1918 and 1919, none; 1920, 30 per cent; 1921, none; 1922, 14 per cent; 1923, 40 per cent; and 1924, 22 per cent (*2*). In 1925 no records were made.

That there is a changing food habit is merely a possibility, and certain facts would tend to show that there is not. The common hosts are still found infested and sometimes are severely injured. The heaviest infestations known on two of the less common hosts, tansy and yarrow, occurred in 1925 and away from any center of infestation. Neither is there proof that the tendency to a single generation, if there is one, is connected with a reduction in number of food plants; in fact, there is every reason to believe that the single generation exists on at least a half-dozen of the more common host plants.

It is likely that from time to time new information will be acquired which will supply many of the missing stages of the insect on the host plants of the list. Some of those listed as attacked by migrants, or under status unknown, may prove to be food plants or complete hosts of the borer. It may also be that new host plants will be found occasionally, especially in those newer areas of severe infestation in the southern part of New England. The probability is, however, that most of the important hosts of this section are now known.

A complete list is given in Table 8 of the known plants upon which the borer has been found in New England, arranged according to the systematic sequence. This table also shows the generations and stages found on each plant and the parts of the plant attacked, and gives classifications showing the relative frequency of infestation and the status of each plant as host of the insect.

SUMMARY

The European corn borer, although primarily a corn insect, has been found on more than 200 different kinds of plants. A number of other plants examined were found to be uninfested. The insect is occasionally a pest of economic importance on plants other than corn. Many of the host plants might become of importance should the borer reach the sections of the country where they commonly occur. Every cultivated host plant may act as a carrier of the insect, and all host plants, especially the weeds and wild plants, may harbor and help perpetuate the pest.

The larvae may attack any or all parts of the plant; the stems are most frequently infested. The injury (the appearance of which is usually characteristic) often results in the partial, sometimes in the total destruction of the plants.

The hosts may be attacked by borers of either or both generations, and all immature stages of the insect have been found on many of them. The seasonal development, characteristics, environment, frequency, and distribution of plants affect their infestation.

The plants are discussed and classified as to their frequency of infestation (their frequency of occurrence being taken into consideration) and as to their status as hosts of the borer. Included is a complete list of the plants upon which the borer has been found, showing these classifications, the generations and stages of the insect found on each, and the parts of the plant attacked.

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